RANCH DAY

OCTOBER 11, 1954

New Mexico Experiment Station, New Mexico Extension Service,
Agricultural Research Service,
Rocky Mountain Forest and Range Experiment Station

Black Grama Range in Good Condition

Experimental Ranch

New Mexico College of A. and M. A.

Jornada Experimental Range

Agricultural Research Service

PROGRAM

FOURTEENTH ANNUAL RANCH DAY
Jornada Experimental Range and College Ranch
October 11, 1954
Las Cruces, New Mexico
Ivan Watson, New Mexico Extension Service, Presiding

8 a.m. Leave Dona Ana County Court House, Las Cruces, New Mexico

8:35 a.m. Stop 1 -- Jornada Experimental Range

New Program for the Jornada -- Fred N. Ares

9:20 a.m. Stop 2 -- Jornada Experimental Range

Drought and Its Effects -- Hudson G. Reynolds
Recovery from Past Droughts on the Jornada Experimental Range -- Harold A. Paulsen

10:15 a.m. Stop 3 -- Jornada Experimental Range

Range Reseeding in Northern New Mexico --
E. J. Dortignac
Cost of Range Reseeding in Northern New Mexico --
H. B. Pingrey

11:30 a.m. Lunch -- Jornada Experimental Range headquarters

12:45 p.m. Welcome-- A. H. Moseman, Director of Forage Crops Research, Agricultural Research Service
Raymond Price, Director, Rocky Mountain Forest and Range Experiment Station
John W. Branson, President, New Mexico A.& M.College

Introduction of guests

Guest speakers

1 p.m. Address--Range Allotment Improvement Program in Colorado -- Leavitt Booth, Past President, Colorado Cattlemen's Association

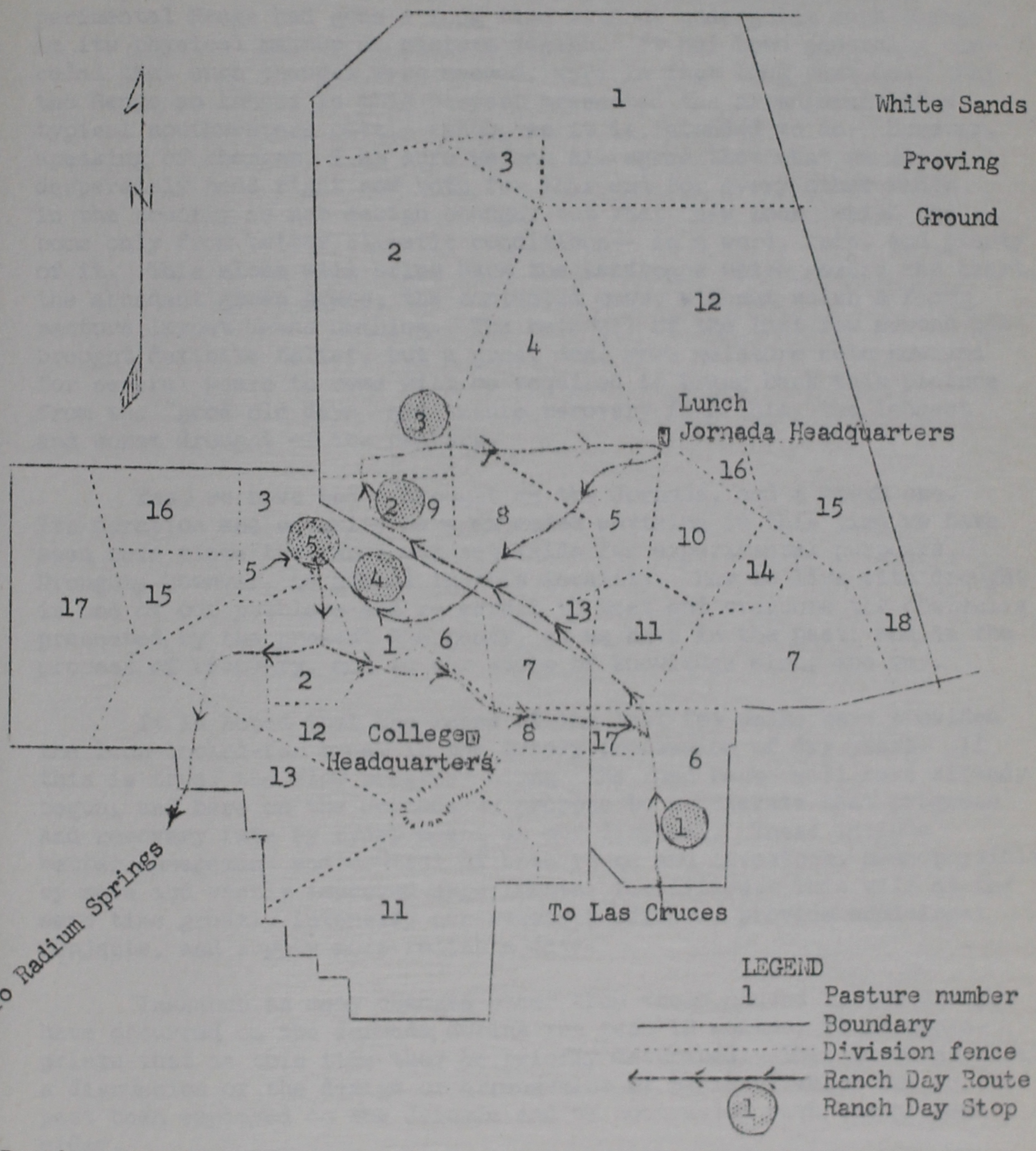
1:30 p.m. Address--Forage Reserve in the Management of the U Ranch -- E. O. Moore, Jr.

2:30 p.m. Stop 4 -- College Ranch

Effect of Degree of Utilization on Drought Kill in Black Grama Grass -- J. J. Norris
Utilization for Range Recovery in Relation to Plant Reproduction Requirements -- K. A. Valentine

3:15 p.m. Stop 5 -- College Ranch

Weights, Gains, and Grades in the Selection of Range Cattle -- R. L. Blackwell
The Effect of the Development of Heifers on Their Production -- J. H. Knox



Portion of College Ranch and Jornada Experimental Range Showing

Ranch Day Route

A NEW PROGRAM FOR THE JORNADA

Fred N. Ares

In the natural order of events, changes and adjustments have to be made to meet changing conditions. Up to last year the Jornada Experimental Range had gone a long time without undergoing much change in its physical makeup or pasture design. It had been generally conceded that such changes were needed, were in fact long past due; that the Range no longer in this respect presented the arrangement of a typical southwestern cattle ranch, as it is intended to do. However, speaking of changes, I am sure we can all agree that what we most desperately need right now both for this and for every other ranch in the country is not design changes but that "new look" which can come only from better climatic conditions-- in a word, rain, and plenty of it. This alone will bring back the landscape which cheers the heart, the abundant green grass, the contented cows, without which a fancy pasture layout means nothing. The rainfall of the last few months has brought definite relief, but a great deal more moisture both now and for several years to come will be required to bring back this picture from the "good old days" and secure recovery from this, the longest and worst drought of the century.

Yes, we have had a drought on the Jornada, and a tough one. Its duration and severity have exceeded anything in this line we have seen here since the range was set aside for experimental purposes. Drought, however, is normal in this locality. How to live with drought is one of our problems and we expect to meet and overcome the obstacles presented by the present emergency, as we have in the past; and in the process of recovery, add to our store of knowledge along the way.

It is hoped that the rains of the last few weeks have provided the long-looked-for break in the dreary procession of dry years. If this is true, the slow progress along "the road back" will have already begun, and here on the Jornada we propose to accelerate that progress and recovery rate by every means at our disposal. These include better management and control of both range and livestock, made possible by more and vastly improved experimental facilities. This will at the same time greatly intensify our research efforts, provide additional projects, and supply more reliable data.

Inasmuch as many changes other than those caused by the drought have occurred on the Jornada during the past 12 months, it is appropriate that at this time they be briefly described. This involves chiefly a discussion of the design or arrangement of pastures which has in the past been employed on the Jornada and as contrasted with the present order.

The Original Jornada Pasture Setup

The accompanying figure 1, a sketch map of the Jornada Range, shows, with minor changes, the arrangement of the experimental pastures in use for the past 30 years and up to 1953. The interior fences subdivided the 193,000-acre range into 9 pastures ranging from 800 acres

in pasture 6a to 83,000 acres in pasture No. 1. In between were pastures with areas varying from 1,800 acres to 40,000. Roughly, the area was divided into forage types, the summer tobosa range being on the east side and the winter or black grama range in smaller pastures on the west. The San Andres mountain pasture was used as a separate unit and grazed on a yearlong basis.

Following the established policy of maintaining a typical ranch here on the Jornada, this arrangement of the pastures represented about the average design or ranch setup in use at the time of the establishment of the range. Fitting the program of range research into this picture, efforts were begun to determine over a long period certain relationships which, when established, would be of practical help and benefit to the ranching industry as a whole in the Southwest.

In order to accomplish this at the very outset, collection of vegetative, climatic, and livestock records was begun and has been maintained with unbroken continuity ever since--a period of nearly 40 years. Use of these parallel records has made it possible to work out and determine such relationships as: (1) the effect of climate on vegetation; (2) the effect of grazing on vegetation, both seasonal and yearlong; and (3) the effect of varying intensities of grazing on vegetation.

Armed with this knowledge and other information, it was then possible to attack and solve such problems as (1) determining grazing capacity of semidesert ranges; (2) development of a system of management to cushion and minimize the disastrous effects of recurrent drought; (3) devising measures to provide better distribution of cattle and more uniform grazing; (4) devising systems of grazing that would permit maintenance and improvement of the range and at the same time yield satisfactory livestock production; (5) improving the grade of livestock, reducing death losses, and increasing calf crops; and (6) reducing the costs of livestock production.

All of the above, set up as our objective in the beginning, have either been reached or very satisfactory progress has been made toward them, over the years on the Jornada Range with the original pasture arrangement. The quadrats, transects, fenced enclosures, gaging stations, and other research installations have made up our test-tube laboratory, while the range pastures have served as the proving ground and areas on which the practical application of the research results could be made and demonstrated. Results have been passed on to those who could use them through Ranch Day programs and in the form of innumerable pamphlets, popular articles, and several Departmental bulletins.

Thus the original system in use on the Jornada served its day. As the research results were applied on similar ranges throughout the Southwest, strides ahead were made in herd and range management. This was especially true on ranges where, because of low land values and other economic limitations, it was not possible to fully develop the area by fencing and constructing needed water facilities, and where ranching was done under rather primitive conditions somewhat resembling operation on the open range.

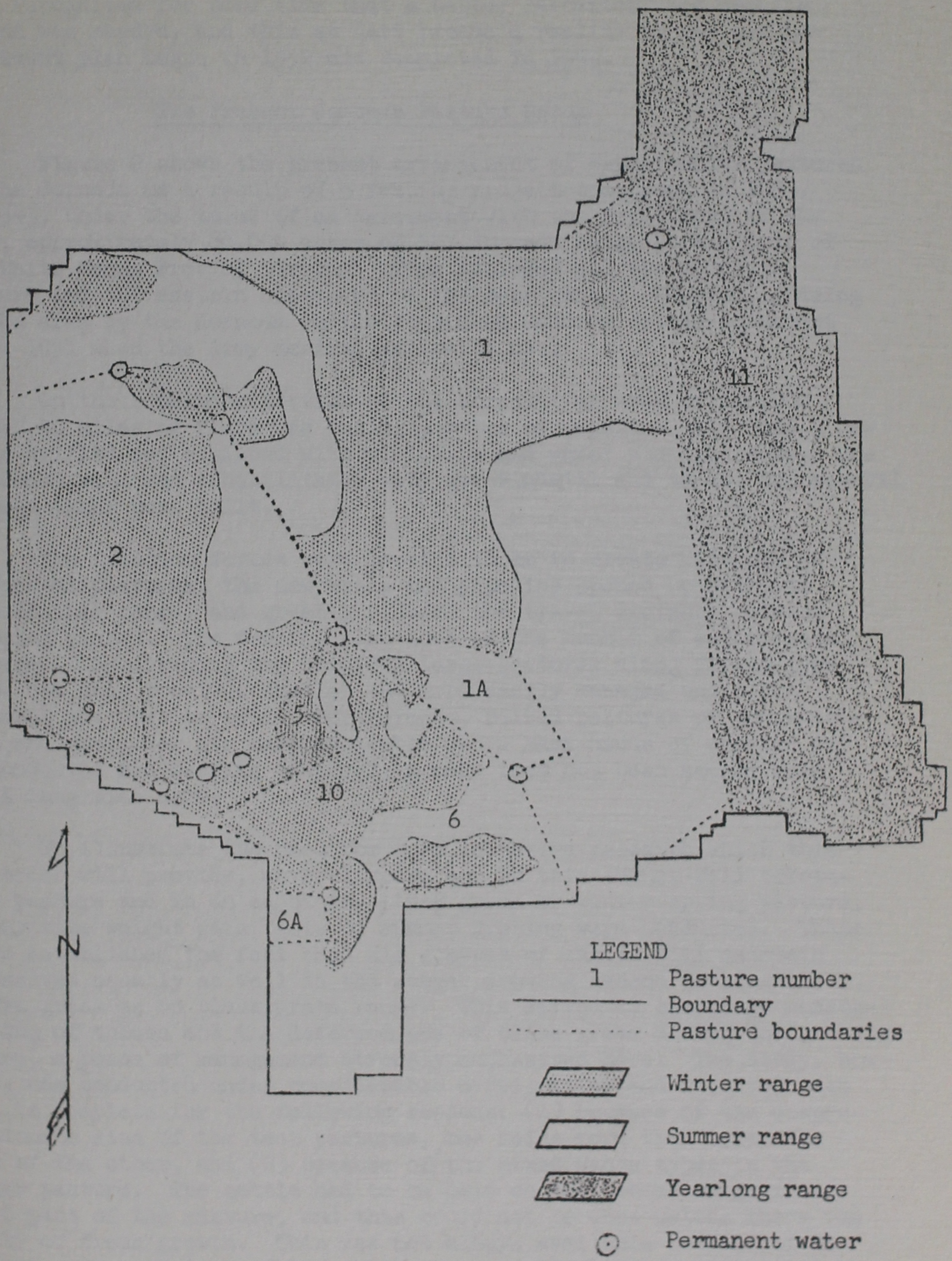
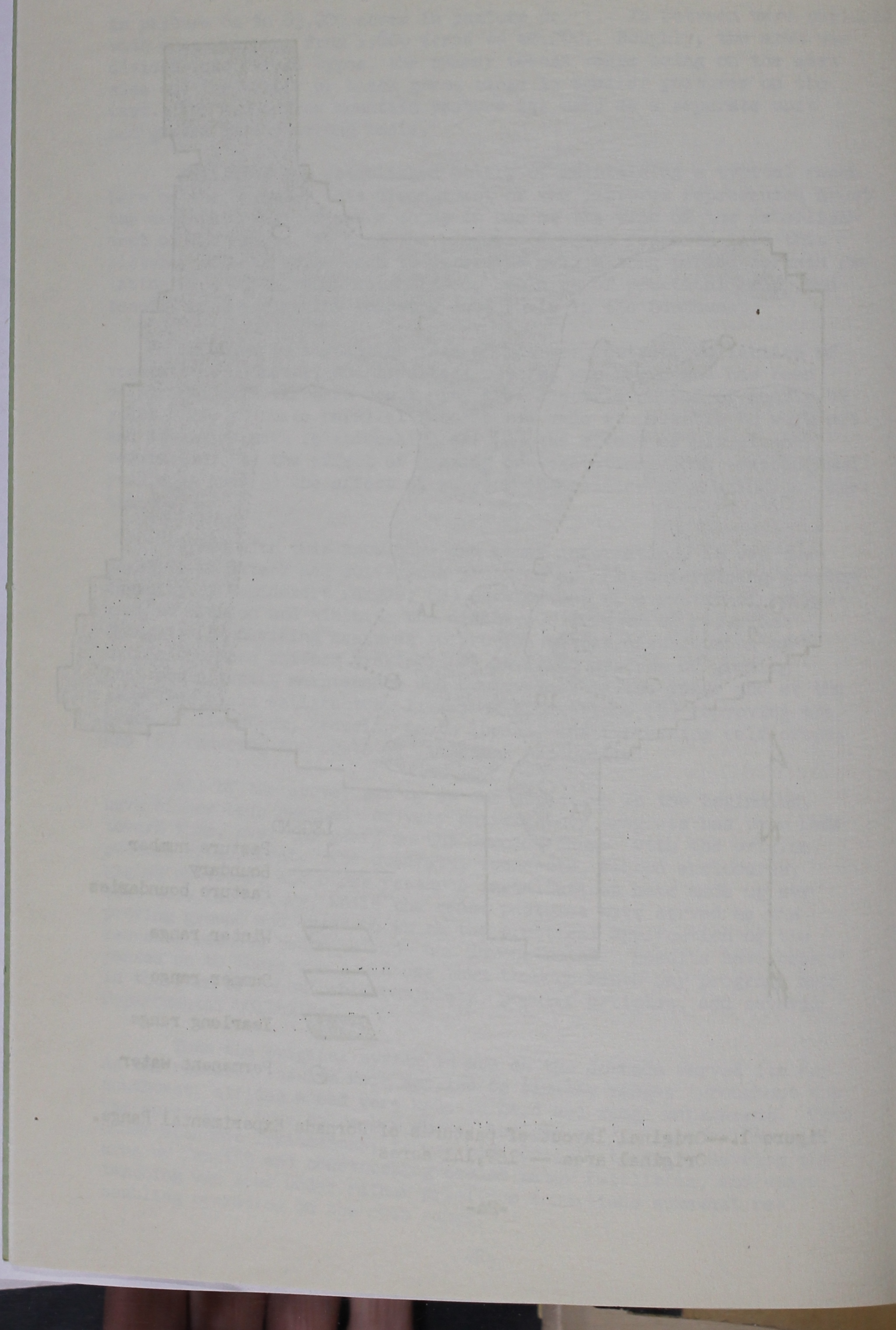


Figure 1.--Original layout of pastures of Jornada Experimental Range.
Original area -- 189,141 acres



With the advent of the era of more intensive ranching, it had been recognized for some time that a better laboratory and proving ground was needed, and this at last became a reality in the new improvement plan begun in 1952 and completed in 1953.

The Present Jornada Pasture Setup

Figure 2 shows the present arrangement of experimental pastures on the Jornada as a result of a fencing project completed in 1953. In 1945, under the terms of an agreement with the Department of the Army, approximately 84,000 acres of the Jornada Range became part of the White Sands Proving Ground. This included all the mountain pasture and the eastern one-third of the mesa range. However, grazing of the area by the Jornada cattle continued under a co-use agreement until 1951 when the Army desired exclusive use.

On the remaining portion of the Jornada, an area of 106,000 acres, 40 miles of fence was built, 5 miles of pipeline laid, and 3 new wells drilled and equipped with windmills and water storage tanks. One abandoned well was rehabilitated with new windmill and tanks; and several surface tanks were built.

The interior fences were located so as to create nine new experimental pastures; the new wells and pipeline opened up hitherto inaccessible range, and greatly reduced the travel distance between watering places. The fencing plan doubled the number of experimental pastures. Subdividing the original large pastures along forage type lines not only provides smaller and more easily managed units but seasonal pastures as well. Furthermore, paired pastures of comparable area and character are made available where many kinds of studies may be conducted and results compared, a need that has been keenly felt for a long time here.

To illustrate the need for more intensive research which this new order will provide, several years ago in this summer-fall tobosa-type pasture and in an adjoining black grama or winter-spring pasture, comparative weight gain tests of summer grazing were conducted. These tests established the fact that all classes of cattle will maintain themselves equally as well in the summer growing season grazing on tobosa grass as on black grama range. This served to encourage seasonal grazing of tobosa and the deferred use of black grama during the growing season, a phase of management strongly emphasized here. The study, however, was conducted under considerable difficulties and required much time to complete for the following reasons: (1) because of the disproportionate size of the test pastures, one being more than twice the area of the other, and (2) because of the mixed range types in the larger pasture. The cattle had to be held on the tobosa range in the south part of the pasture, and this could not be done unless there was plenty of fresh growth. This was not always available because of deficient and spotted rainfall. With the present plan, several smaller pastures both of tobosa and black grama and of approximately the same area are now available for such projects.

Other going projects are to be continued and work will be greatly facilitated by the improved arrangement which will make possible the collection of more accurate, exact, and reliable data. Most of our current projects have been temporarily suspended because of the drought removal of nearly all our experimental herd. With the advent of more favorable rainfall and forage conditions, the herd will be replaced and the current experimental range projects resumed. Some of these projects are as follows:

1. Supplemental feeding for weight gains and better calf crops.

2. Different feeding methods to secure better grazing use patterns in pastures.

3. Continue study of other methods for distribution control such as salting the range, water control, and herding.

4. Continue herd management methods to prevent losses and otherwise reduce costs of production of cattle.

Proposed new projects, now made possible by the present pasture plan, include the following:

1. Controlled breeding for better calf crops, and more uniform size, weight, and quality of calves.

2. Improving distribution of cattle on range through location of shade structures and rubbing posts on remote areas.

3. Cross breeding of Hereford yearling heifers with Angus bulls to secure earlier and hazard-free calving.

4. Install the Bell Ranch grade and record system for improving the quality of the breeding herd.

Given reasonable climatic breaks, the Jornada Experimental Range with its new facilities bids fair to implement a long record of research accomplishments with better and more effective experiments in the future. These, it is hoped, will keep pace with and provide the answers to ranching problems as they develop in future years.

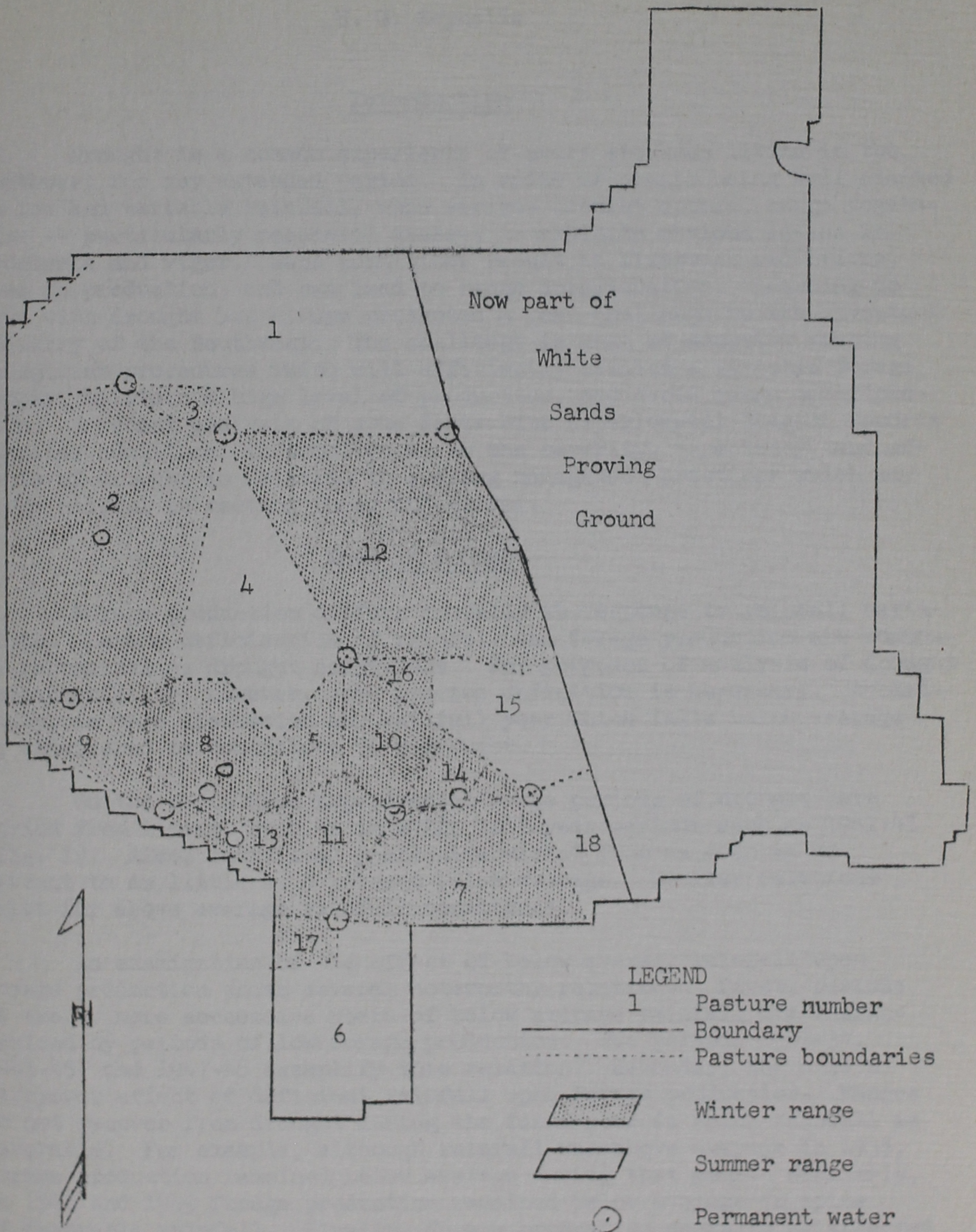


Figure 2.--Present layout of pastures of Jornada Experimental Range.
Present area -- 105,713 acres

DROUGHT AND ITS EFFECTS

H. G. Reynolds

Introduction

Drought is a common experience of every stockman living in the Southwest for any extended period. In spite of plants being well adapted to low and variable rainfall, when serious drought occurs, range vegetation -- particularly perennial grasses -- exhibits obvious losses in abundance and vigor. Such conditions result in livestock reductions, loss in production, and can lead to range deterioration. Learning to live with drought has always presented a real challenge to the livestock industry of the Southwest. The challenge is that of adopting grazing management procedures which will efficiently utilize a variable forage supply, maintain a high level of production, and avoid range deterioration. A recent analysis of some Santa Rita Experimental Range[1/] records supplies additional information as to the severity, expectancy, and effects of drought in relation to grazing management practices which may prove helpful in meeting these objectives.

What is Drought

Forage production differs annually in response to rainfall variations. Severe deficiencies of rainfall and forage production are commonly recognized as drought conditions. For purposes of analysis of drought characteristics, however, some precise definition is necessary. Accordingly, in this discussion any rainfall year which falls below average is considered to contribute to a drought.

On the Santa Rita Experimental Range periods of drought have varied from 1 year, such as in 1928, to 5-year periods such as 1941-45 (fig. 1). Also, individual years have varied from as much as 40 percent to as little as 5 percent below average. Similar relations exist for above average rainfall conditions.

An examination of the effect of below average rainfall upon forage production shows several noteworthy relations. First, periods of two or more successive years of below average rainfall are characterized by periods of low forage production. The periods 1933-34, 1941-45, and 1947-48 exemplify this relation. Secondly, there is a carryover effect of deficient rainfall upon forage production. Ranges do not recover from drought during the first year in which rainfall is favorable. For example, although rainfall was above average in 1935, forage production remained below average during that year. Similarly, in 1946 and 1949 forage production remained below average in spite of favorable rainfall. Finally, forage production seems to be affected both by the amount rainfall departs from average conditions and the

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1/An experimental area maintained by the Rocky Mountain Forest and Range Experiment Station located about 30 miles south of Tucson, Arizona.

number of years in succession which it remains below average. Although individual years were only slightly below average, the period 1941-45 had as serious an effect upon forage production as the period 1933-34, in which individual years were considerably below average.

Effects of Drought

Loss in forage production is associated with reductions in vigor, ground cover, and proportions of different species in the composition. When vigor becomes too low, parts of or entire plants begin to die leading to a loss in ground cover. Changes in relative abundance or composition of perennial grasses usually accompany loss in ground cover on mixed grama ranges. Some species of grass are more susceptible to drought than others. A range characterized by drought-susceptible species therefore suffers more serious losses in forage production than one made up of drought-resistant species. Moreover, undesirable woody species, such as mesquite, because of their drought resistance, may gain at the expense of perennial grasses during drought periods. When taken together, the loss in vigor, ground cover, and drought-susceptible species is all reflected in less forage production.

Drought Severity

Drought severity is a function of how far and for what period rainfall departs from average conditions. By comparing periods of departures from average rainfall with forage production departures for the same period, the relation between the rainfall and forage production can be established. When rainfall departures are expressed as a percent of average and forage is expressed in terms of pounds per acre, the curves of figure 2 are obtained.

Forage production is affected differently during periods of deficiencies of rainfall than it is during periods of excesses of rainfall (fig. 2). As successive years of below average rainfall accumulate, forage production losses occur at an increasing rate. This helps to explain why the effects of droughts appear so suddenly and reach such serious proportions so rapidly. Years of above average rainfall not only require a greater length of period or amount of departure for the same effect, but forage gains accrue at a decreasing rate. This emphasizes the desirability of caring for a range after a drought period. The rate of range deterioration as a result of drought is much faster than the recovery during favorable rainfall periods.

For purposes of defining conditions of above and below average rainfall, several arbitrary categories are assumed. For above average rainfall conditions the categories of fair, good, and excellent conditions are adopted. The categories of slight, moderate, and severe drought are used for periods of below average rainfall. By using these categories of excess or deficiency of rainfall it is possible to compute the expectancy of any such period based upon analysis of rainfall records.

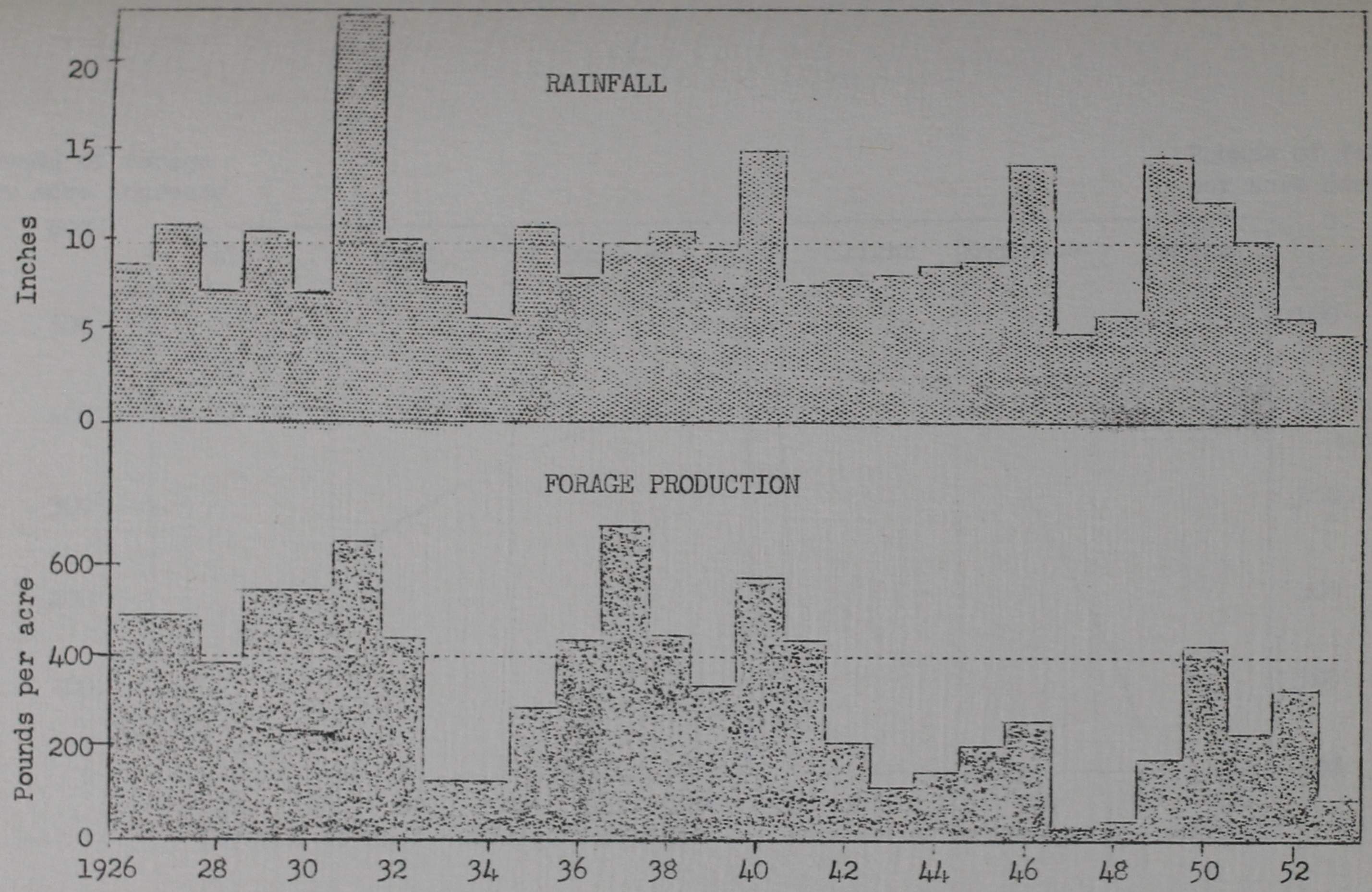

Figure 1.--A comparison of June-September rainfall and forage production on a portion of the Santa Rita Experimental Range for the years 1926-53.

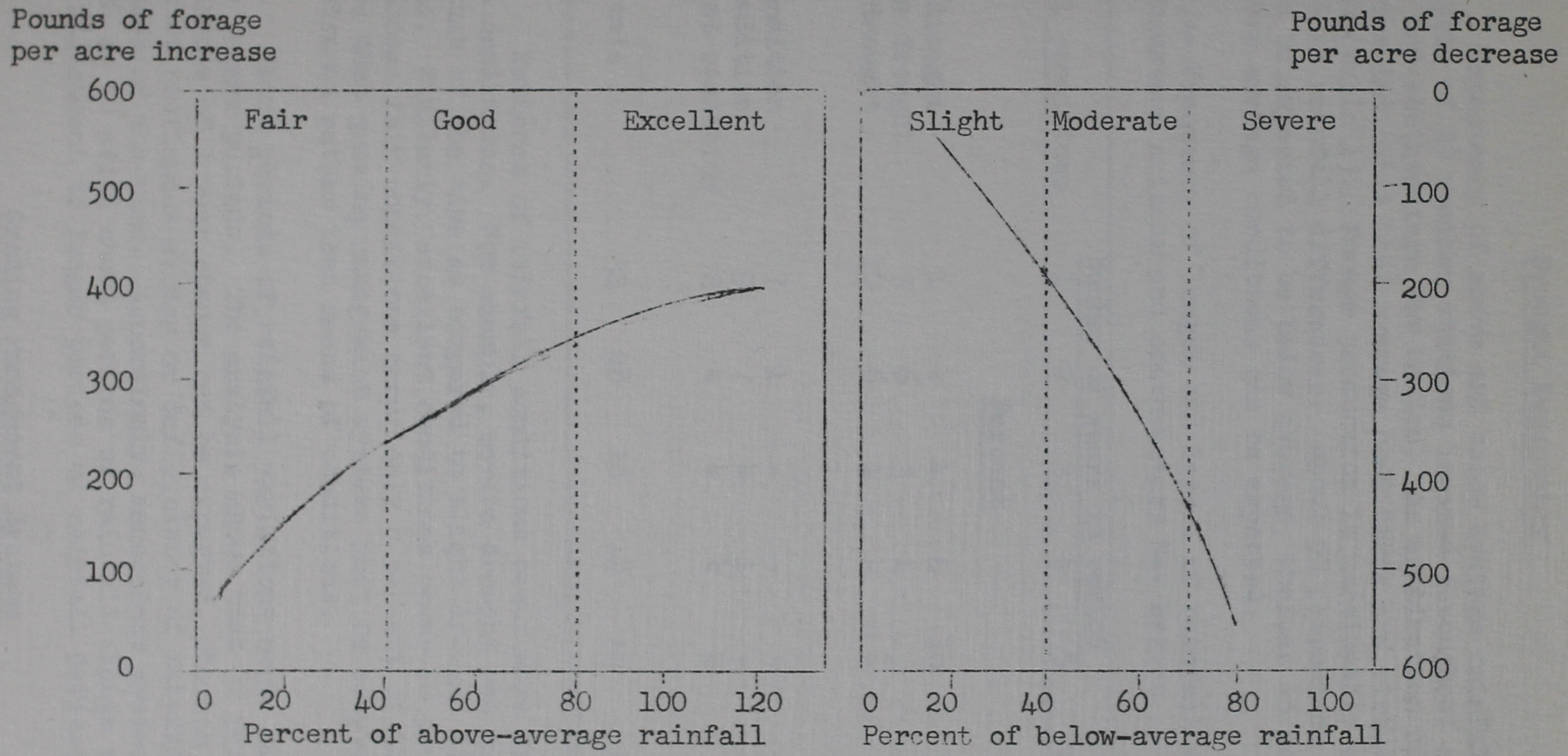

Figure 2.--Effect of rainfall departures from average conditions upon increase or decrease in forage production over average conditions

Drought Expectancy

Expectancy of above and below average rainfall is based upon an analysis of 39 weather stations located throughout southeastern Arizona and southwestern New Mexico. An examination of rainfall expectancies indicates that average conditions are virtually nonexistent (table 1). Forage production is continually changing in response to rainfall differences. About 55 percent of the time rainfall can be expected to be below average, whereas 45 percent of the time above average conditions can be expected.

Table 1.-- Frequency of length and degree of rainfall variations for southeastern Arizona and southwestern New Mexico

Rainfall conditions	Number of years in period					Totals
	1	2	3	4	5	
	Percent					
Severe drought	1	4	4	6	10	25
Moderate drought	3	6	3	1	-	13
Slight drought	10	6	1	-	-	17
						55
Fair condition	7	1	-	-	-	8
Good condition	9	7	4	1	-	21
Excellent condition	2	4	4	4	2	16
						45
Totals	32	28	16	12	12	100

Extremes of rainfall conditions occur more frequently than do mean conditions. For example, severe drought can be expected about 25 percent of the time as compared to slight drought 17 percent of the time. Similarly, excellent conditions occur 16 percent of the time whereas fair conditions occur only 8 percent of the time. This suggests that grazing management systems must be adapted to dealing with extremes rather than means of conditions.

Short periods of rainfall variations occur more frequently than do longer periods. The analysis shows that 32 percent of the time periods of 1 year change can be expected, whereas periods 4 or 5 years of continuous excess or deficiciency of rainfall occur only 12 percent of the time. Accordingly, management systems must be devised so as to avoid short periods of rainfall change as well as to permit adjustment to longer periods of rainfall deficiency or excess.

Grazing Management Systems

Any grazing management system for dealing with drought should include among its objectives the minimizing of range deterioration, stability of operation, and efficient use of forage.

Utilization standards.-- Range deterioration due to drought can be minimized by adherence to utilization standards. This means leaving some perennial grass growth ungrazed each year for plant and soil maintenance. For southwestern perennial grasses, at least 35 to 65 percent of the total herbage material should remain at the end of the grazing season. This amount of material is the minimum of insurance for plant and soil deterioration. Only the remaining herbage produced annually should be considered to be usable as forage.

Constant vs. flexible stocking.-- A management system using constant stocking proposes to graze a herd of about the same number of cattle over the years. The number of animals in the herd would have to be sufficiently below average forage production to be able to avoid adjustments in all but the most severe drought years. At the other extreme is a system of management so flexible that annual adjustments in numbers will be made to take advantage of the different amounts of forage produced each year. Between these two extremes are many compromises and alternatives.

To compare the above extremes of yearlong grazing systems, stocking records were analyzed for a 20,000-acre unit of the Santa Rita Experimental Range for the period 1939-53. Calculations were based on a calf crop of 90 percent and animal weights of 400 pounds for calves, 700 pounds for yearlings, and 1,000 pounds for cows. Actual prices received for the various classes of animals during the study period were used for computing income.

Under a system of constant stocking, stocking can be set any amount below average forage production which is desired. Amount of stocking adjustments required as a result of poor forage years decrease as grazing becomes more conservative. If stocking had been set at 75 percent of average forage production, adjustments would have had to be made 38 percent of the time. If set at 50 percent of average forage production, adjustments would have been necessary only 24 percent of the time. By stocking at 50 percent of average forage production considerable stability is realized in the livestock operation (fig. 3). A constant number of animals could have been grazed except for 1948. Based upon prices received during the study period estimated average annual income averaged about $20,000.

The flexible system of stocking used 50 percent of the forage for breeding animals. The remaining forage was devoted to weaners which were sold as long yearlings. Under this system average annual income was estimated to be about $30,000. This is gross income and does not consider the expense of handling the additional animals.

Other management practices.-- Proper fencing and good control and distribution of water are helpful in avoiding the deleterious effects of drought. Oftentimes droughts are extremely local. Severely affected portions can sometimes be isolated for treatment if the range is properly fenced. Similarly, by controlling watering places, portions of a range suffering from drought can be rested. After a severe drought every opportunity should be taken to promote redistribution of animals, and to rest seriously affected units to restore range productivity.

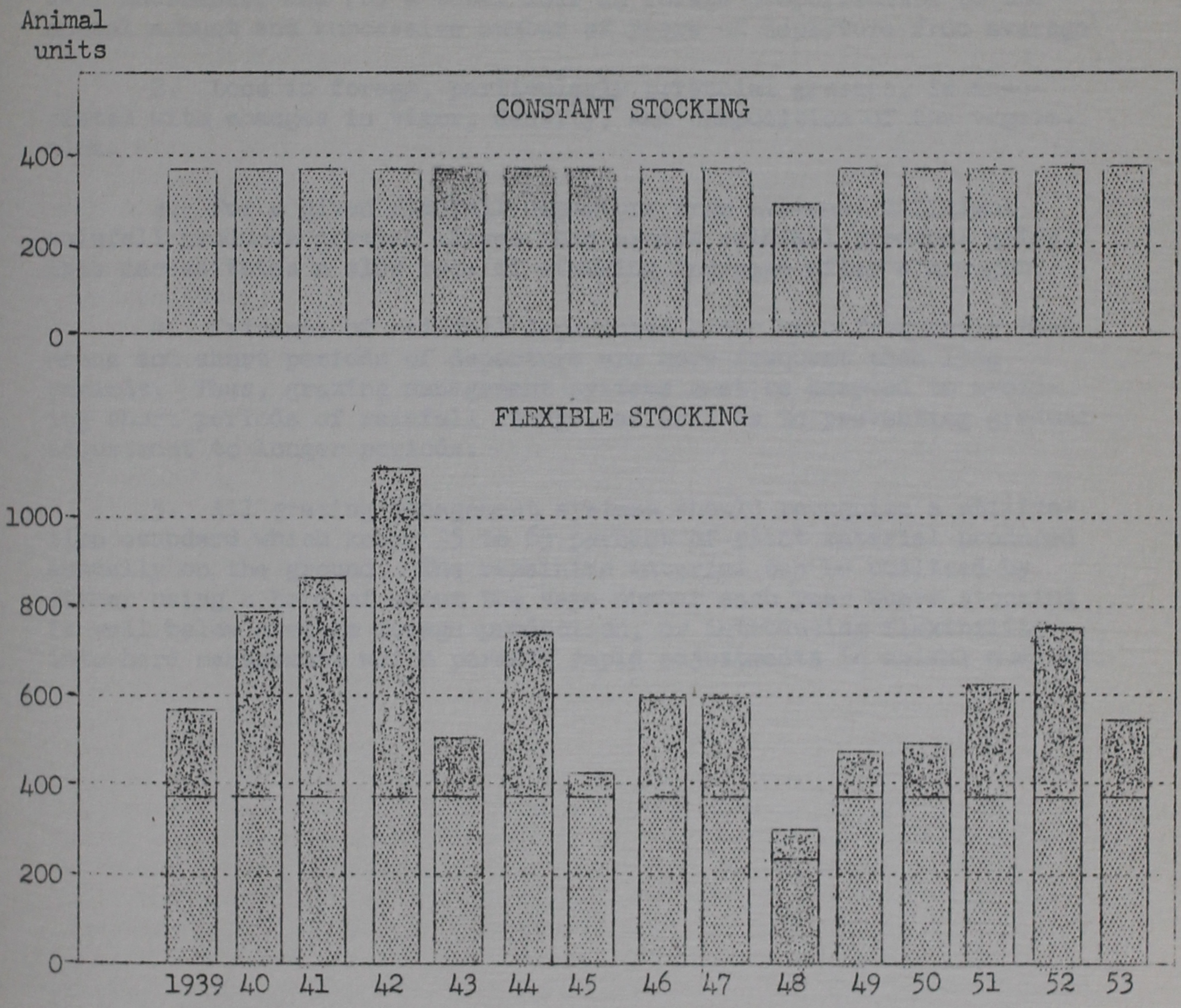

Figure 3.--A comparison of constant stocking rates set at 50 percent of average forage production, and flexible stocking rates varied to utilize all annual forage for a portion of the Santa Rita Experimental Range. (Forage is considered to be 50 percent of total grass herbage.)

Summary

1. Below average rainfall for more than 2 successive years results in (a) a carryover loss of forage for at least 1 year after rainfall increases, and (b) a total loss in forage proportionate to the annual amount and successive number of years of departure from average.

2. Loss in forage, particularly perennial grasses, is associated with changes in vigor, density, and composition of the vegetation.

3. For a given rainfall departure from average, deficient rainfall produces greater losses than excess rainfall produces gains. This necessitates a slow rate of stocking increase after a drought.

4. Extremes of rainfall departures occur more frequently than means and short periods of departure are more frequent than long periods. Thus, grazing management systems must be adapted to avoiding short periods of rainfall change, as well as to preventing gradual adjustment to longer periods.

5. All grazing management systems should recognize a utilization standard which keeps 35 to 65 percent of plant material produced annually on the ground. The remaining material can be utilized by either using a herd of about the same number each year where stocking is well below average forage production, or introducing flexibility into herd management which permits rapid adjustments in animal numbers.

RECOVERY FROM PAST DROUGHTS ON THE JORNADA EXPERIMENTAL RANGE

H. A. Paulsen, Jr.

Introduction

Since 1915 records of climate, vegetation, and livestock have been maintained and intensified on the Jornada Experimental Range and today cover the longest period of continuous records of these subjects to be found in southern New Mexico. Thirty-nine years of record is sufficiently long to cover most of the extremes encountered in either annual or short term fluctuations in records of this type. Furthermore, enough time has elapsed to establish rather conclusively the general, longtime trends.

The portion of the Jornada through which we have just driven represents some of the best black grama grassland found on the entire experimental range. It is on this vegetation type that the main portion of the Jornada management is centered because it represents the highest grazing potential of the semidesert ranges. The grass vegetation which is predominantly black grama with minor percentages of dropseed and Aristida is well suited for maintenance requirements of cattle during the winter-spring grazing season. This type of range may be grazed throughout the year, but since tobosa grass, which is also one of the main components of the forage resource on the Jornada, is primarily valuable during the summer growing season, black grama range is generally reserved for use during the dormant period.

The area in which we have stopped typifies the reduction in stand which can take place on good condition black grama range in a relatively few years. Grazing cannot be held mainly responsible since there still remains sufficient stubble that the area must be considered as having been only lightly or moderately used. Nevertheless, most of the black grama clumps contain only a very few living stems and many are entirely dead. While some growth has been made this year and a nucleus still persists for re-establishing the stand, continued drought will virtually wipe it out completely. If the current drought period is ended, management of the range will require careful handling to permit the most rapid recovery and to insure readiness for the future droughts which are certain to follow.

It is the purpose of this discussion to present some of the findings from a detailed study of the Jornada records on the subject of recovery from drought. This problem faces many stockmen throughout southern New Mexico and although no one practice for meeting the drought recovery problem is universally acceptable, certain practices have been helpful in restoring the range resource.

Characteristics of Past Droughts

Precipitation records are the most easily recognized criteria for measurement of duration and intensity of drought. Standards which establish drought years in contrast to good years are arbitrary and open to question unless their bases are thoroughly explained. Thus

drought may be considered to exist whenever rainfall is below the long-time average. However, many years in which the precipitation is below average actually produce an above average forage crop. This is often the case if rainfall is entirely effective, insofar as timing and intensity are favorable to the development of the forage crop. For example, on the Jornada seasonal precipitation in 1950 was only 87 percent of average and yet produced a forage crop of 125 percent of average. Conversely, in grazing year 1942 there was only an 84 percent of average forage crop, even though seasonal precipitation was 204 percent of average.

Seasonal precipitation records from six rain gages in the general area of the tour route indicate that rainfall during July, August, and September has averaged 4.44 inches during 38 years of record. Rainfall during this 3-month period, when forage growth conditions are most often optimum, has proven to be closely associated with forage production. During the 38 years, 21 have been below the longtime average, only 14 have been above and 3 have been average. As shown in figure 1a, there have not been over two consecutive years of above average seasonal precipitation. However, there have been periods of 3, 5, and 6 years when the seasonal rainfall has been only average or below. It is this grouping of low rainfall years which is especially damaging to the forage plants.

In the first of these groups of low rainfall years which are shown on the Jornada records for 1917 through 1919, seasonal precipitation was only 58 percent of average. Then followed 2 years of favorable rainfall. Before recovery from the 1917-1919 drought the second group of consecutive low rainfall years began in 1922. The 5-year period, 1922 through 1926, was 20 percent below average and while somewhat less severe than the earlier 3-year drought period as measured by the departure from average, the additional 2 years coupled with already weakened forage plants made this drought period particularly severe.

The span of years 1927 to 1947 was considered to be a moist period but 9 of the 21 years were still 23 percent below average. However, the other 12 years were 46 percent above average although there were never more than 2 consecutive years of above average precipitation. The extreme fluctuations of seasonal rainfall are clearly shown for this period in figure 1a.

In 1948 the present drought cycle began on the Jornada. From 1948 through 1953 the seasonal precipitation has only been 69 percent of the 38-year average. While the current drought period has lasted longer than any previous one on the Jornada records, it has also contained 2 years, in the summers of 1948 and 1951, when rainfall was the lowest on record. Only 32 and 26 percent of the average of 4.44 inches of seasonal precipitation fell in these 2 years, respectively. In contrast, the devastating drought of 1934 was sandwiched between high rainfall years. Although only 1.68 inches of rain fell during the growing season, the situation was alleviated the following year when the area received nearly 6 inches of precipitation in the summer.

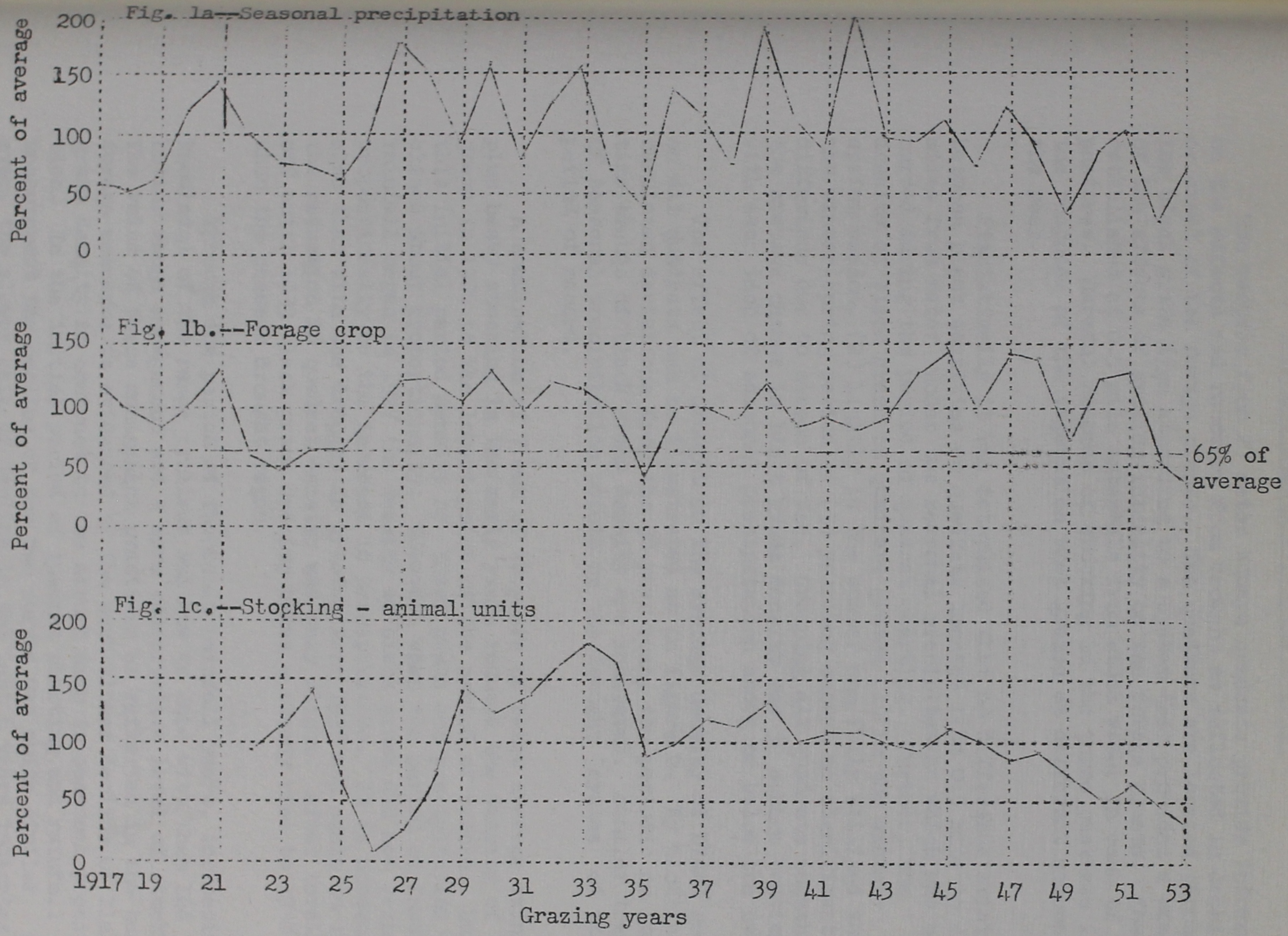

Figure 1.--Related data for seasonal precipitation, forage crop, and stocking on part of the Jornada Experimental Range

Drought Impact on Forage Plants

The records from 27 meter square quadrats provide information on the effects and recovery from drought as reflected in density or stand of the forage plants. The quadrats are located throughout the black grama type according to a system that provides a measure of the effects of grazing intensity on the forage plants. They are established at 0.5 mile intervals from stock water in each of three pastures. Careful records of stocking in the three pastures indicate the response of the vegetation when grazed at different seasons of the year.

Statistically it was determined that no difference exists between plant densities on quadrats located from 0.5 mile to 2.5 miles from water under the seasonal precipitation which has occurred during the period of quadrat charting. Further, the density of black grama on quadrats grazed (1) in the winter-spring season, (2) lightly in the summer and fully utilized through the winter-spring period or (3) yearlong showed no significant difference due to season of use. Grouping all quadrats together, the average change in black grama density was 32 square centimeters with each inch of seasonal precipitation above or below the average.

The effect of drought on the average density of black grama on all quadrats can be illustrated as in figure 2. By plotting cumulated deviations from the 38-year mean, the periodic or long-time trends of black grama density are indicated. Similar treatment of seasonal precipitation points up the drought "cycles" of the period of record.

A combination of 7 out of 10 years of below average rainfall plus heavy stocking in the early years reduced the density of black grama in 1926 to the lowest point of the period of record. During this initial period density of black grama and precipitation declined about proportionally. However, when the period of favorable rainfall began in 1927 the density of black grama did not respond proportionally to the increase in precipitation. It is noteworthy also that with the drought in grazing year 1935 and again in 1938 the reduction in quadrat density was only slight. After leveling off until 1939 black grama density began a steady rise to 1948 when the present drought began.

Through the period of favorable rainfall years, increasing knowledge of the range problems and how to cope with them led to better range management and a more conservative level of stocking. The value of these management practices as reflected in the basic forage resource is evidenced by the much slower decline of black grama density in contrast to the abrupt drop in seasonal precipitation. In the initial period of quadrat charting and rainfall measurement the decline of the two curves was quite similar. However, the slower rate of decline in the last 6 years indicates that the condition of the forage and the use to which it was subjected had minimized the effect of deficient rainfall and when adequate rainfall again comes the grass stand will more quickly recover.

Effect of Drought on the Forage Crop

While plant density is important in evaluation of a range area, perhaps of more significance to the stockman is the range forage crop, since it represents that portion of the grass resource which can be converted into beef. The forage crop is an expression of two factors: (1) the density of the plants or how much ground surface they occupy and (2) the height of the forage plants. Density responds comparatively more slowly to changes in precipitation than does forage plant height growth. Consequently it is possible to obtain a fair forage crop if the plants retain sufficient vigor to take advantage of available moisture even though the density has not entirely recovered from a past drought. A decline in density is usually preceded by a reduction in plant vigor and also, prior to an increase in density, there is usually a recovery of vigor which is often manifested first in increased height growth.

The recovery of the range forage following one or a series of drought years is evident in a comparison of figures 1a and 1b. If the vigor of the forage plants has been maintained as high as possible, the extremes of a widely fluctuating rainfall pattern are minimized. For example, if the drought sequences of 1917-1919, 1922-1926 and the present one beginning in 1948 are omitted, in only 6 years did the forage crop fall appreciably below average and in only 1 year did it drop below 65 percent of average.

In these two figures it is also evident that in general the reductions in forage crop take place more slowly than do changes in precipitation. In grazing year 1948, for example, precipitation dropped to 91 percent of average, a drop of nearly 50 percent from 1947. The following year it dropped to only 32 percent of average but then increased the following 2 years to 87 and 100 percent of average. During this same period the forage crop lost only 5 percent in 1948 and dropped to 71 percent of average the next year, the year in which seasonal precipitation averaged only 1.44 inches. In the next 2 years, however, the forage crop was again over 20 percent above average in both years. Other similar examples of the increased stability of the forage crop in contrast to the wide variations in precipitation are to be found in the two figures.

Restocking After Drought

A plan of stocking for semidesert ranges of southern New Mexico should strive toward stability with a minimum of fluctuation in most years. It should be sufficiently conservative that major changes in stocking are necessary only in the extreme drought periods such as we are currently experiencing on the Jornada.

The basis for stocking on the Jornada has been established at 65 percent of the average forage crop. This has provided sufficient forage in the three pastures during all but 5 years. In addition, it permits a carryover or reserve of forage in most years. This has proven to be good insurance when drought years follow above average years of forage production or, as is often the case, in furnishing a reserve to fall back on if forage growth is delayed the following year.

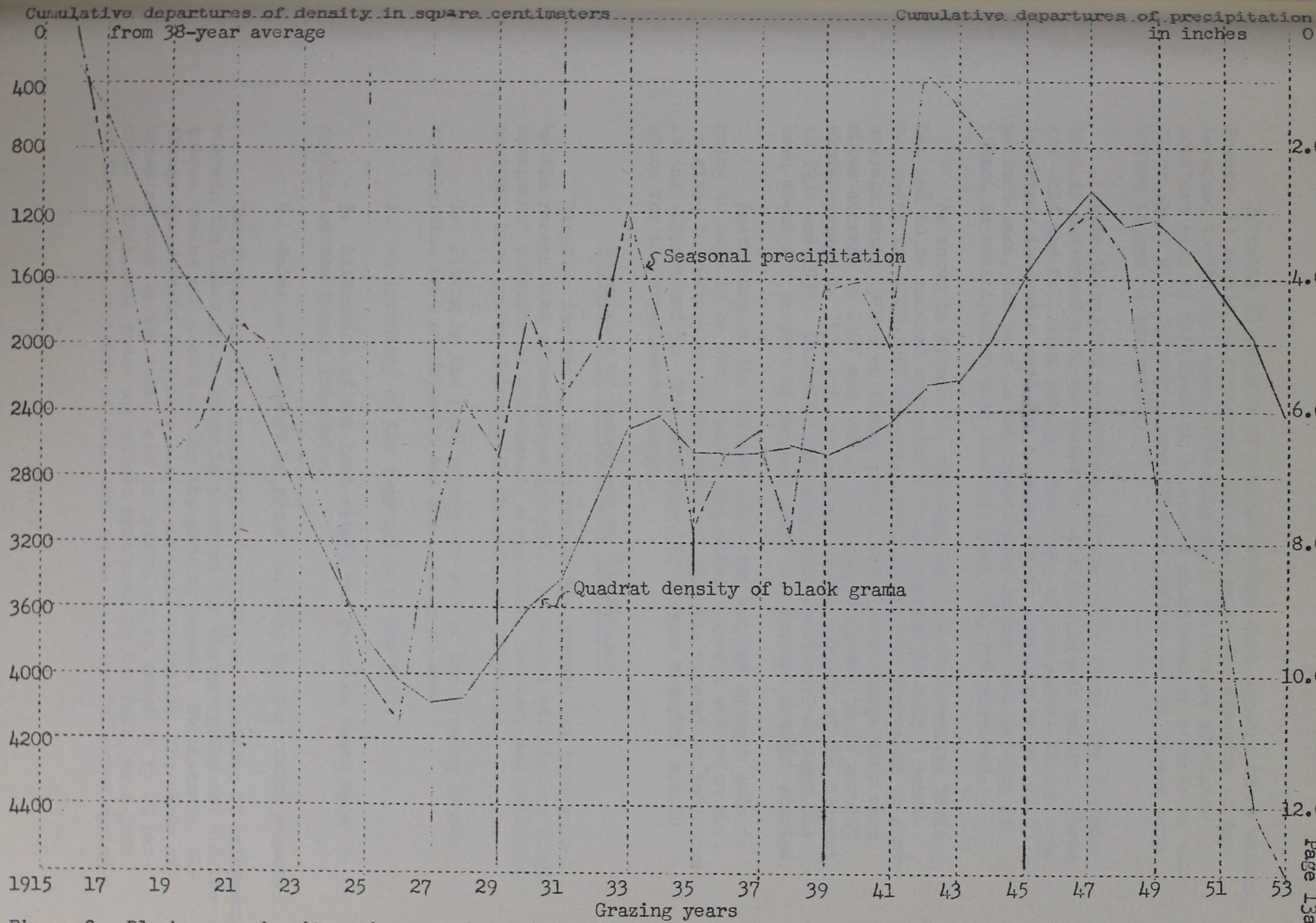

Figure 2.—Black grama density and seasonal precipitation expressed in cumulative deviations from the means.

If using 65 percent of average forage crop appears to be wasting forage, it should be remembered that the basis for stocking is determined in the fall when it is impossible to foresee if winter moisture will be deficient or if spring sandstorms or rodents or some other agent will destroy a considerable portion of the forage crop before it can be harvested.

When infrequent exceptional forage crops occur, the Jornada herd is increased with purchased or hold-over weaner calves. These are sold the following spring. Moreover, if the annual forage crop inventory indicates need for a reduction in stocking below the 65 percent base, the herd is cut accordingly rather than holding it intact in anticipation that the next year will bring relief.

As shown in figure 1c, stocking on this conservative basis has had to be reduced appreciably below average in only 9 years. Following the 1922-1926 drought, stocking was not increased to above average until 1929 even though precipitation and forage crop were above average in 1927 and 1928. Stocking increased to 82 percent above average in 1933 but was reduced as the results of the drought in 1934 and 1935. Stocking following this short-term drought has been about 107 percent of average until the present drought started.

Restocking on the Jornada after the current drought ends is going to have to be conservative and slow. Careful attention must be given to restocking on the basis of what the vegetation indicates it can support and in the knowledge that future droughts are in store for the experimental range.

Essentials of Management on the Jornada

Briefly, the entire management of the Jornada has been guided by the recognition of recurrent drought. As stated earlier, no single management practice is universally acceptable; however, the following measures have proven valuable in the Jornada operation:

1. Sizing up the herd before the end of the growing season to determine what adjustments can most easily be made.

2. An inventory of the vegetation in the fall.

3. Allocation of the herd within the pastures based upon results of the forage inventory.

4. Sales or purchases to shape the herd for the coming season.

The foregoing are supplemented by additional features of management wherein the black grama range is reserved for winter-spring use and the tobosa swales are grazed during the growing season. Furthermore, although the Jornada is principally a cow-calf operation, the ratio of breeding cows to the total herd is maintained at about 55 to 60 percent. Additional stock are either purchased in the fall, or a part of the natural increase is held over to be sold the following spring.

RANGE RESEEDING IN NORTHERN NEW MEXICO

E. J. Dortignac

Reseeding in northern New Mexico is no longer new nor experimental but is fast becoming a recognized range improvement practice. Over 45,000 acres of low forage-producing national forest rangelands have been plowed and reseeded mostly to crested wheatgrass since 1946. The Bureau of Land Management has successfully reseeded public domain lands and many ranchers have cleared and reseeded extensive acreages. We are on the threshold of a widespread range rehabilitation program if the present interest being shown by private owners, State and Federal agencies is any indication. Reseeded ranges should provide an ever increasing portion of the forage requirements during the next decade.

Forest Service plantings have had a success ratio of 95 percent. These good results may seem unusual since plantings were made during a period of drought. However, the successful program of reseeding is a direct result of sound and practical application of findings obtained under intensive investigations conducted by Forest Service Research from 1945 to 1952.

Research Program

The Forest Service started intensive experimental plantings in 1945. Experimental plantings were established at 25 locations as shown in figure 1. Most of the important vegetation zones were represented with 6 sites in woodland, 5 in sagebrush, 3 in ponderosa pine, 1 in pine-woodland, 7 in semidesert grassland, and 1 in an old forest burn. Although plots were fairly well scattered throughout the State, more were established in the Rio Grande Basin in north-central New Mexico than in other sections. The Rio Grande Basin has a large number of people directly dependent on the forage resource and the need for early spring forage is acute. Reseeding appeared a most logical solution. The southern portion of the State was studied less intensively.

In carrying on the experimental work a number of different kinds of plots were utilized. The adaptation plots were actually small nurseries testing numerous species and strains. In all, about 300 species including wheatgrasses, legumes, gramas, bromes, wildryes, lovegrasses, dropseeds, fescues, bluegrasses, andropogons, muhlys, panicums, and needlegrasses. From results of adaptation trials additional larger plots were installed to test species yield, methods of ground and seedbed preparation, planting methods including rate and depth of seeding as well as row spacings and time of planting. Using results of these experimental plantings, the Forest Service embarked on a large-scale range renovation and planting project. On questionable sites pilot plantings varying from 1 to 30 acres and utilizing experimental findings were established prior to undertaking large-scale planting.

At present, there are some 40 project plantings scattered over the Carson, Santa Fe, and Cibola National Forests, the larger sized areas being shown in figure 1.

Reseeding in the Pine, Moist Woodland, and Sagebrush Zones

Crested wheatgrass

In general, crested wheatgrass has proven far superior to any other species in the experimental, pilot and project plantings in northern New Mexico. It is the most satisfactory grass for reseeding the pine, woodland, and sagebrush zones where annual precipitation averages between 14 and 18 inches (figure 1). This has been fortunate in that crested wheatgrass is a cool-weather grower providing forage early in the spring when most needed, before any of the native grasses begin to green up. Moreover, crested wheatgrass is drought-hardy by its habit of becoming dormant during hot, dry periods. Apparently, it is unable to withstand the hotter areas at lower elevations in southern New Mexico but losses due to heat are confounded with drought. Crested wheatgrass has produced a large volume and a good quality of herbage, out-producing adjacent deteriorated native ranges 8 to 12 times.

Another favorable characteristic of crested wheatgrass is the long period of viability of its seed. Seed collected in 1945 showed equally good germination 9 years later. This factor partially accounts for the present practice of waiting several years before classifying a reseeded area a failure. Many plantings have germinated and been successfully established 2 or 3 years after sowing, particularly on areas where unfavorable climatic conditions prevailed.

Crested wheatgrass does best on medium textured soils and, because of its deep rooted characteristic, it will produce the most herbage for a given amount of precipitation on the deeper alluvial soils. Much lower production is obtained on shallow rocky residual soils of the woodland zone with limited opportunity for storage of over-winter precipitation. Likewise, very sandy or heavy clays will produce below-average yields.

Herbage production varies with soil and climate but the amount and distribution of moisture apparently is the controlling factor. Annual yield of dry herbage has ranged from 300 to 1,600 pounds per acre depending on the amount and timeliness of precipitation. Crested wheatgrass is a cool-weather grower commencing its growth early in the spring. It does best where over-winter snow accumulation is adequate to moisten the soil profile during the spring snowmelt period. Rain and snow received in April, May, and early June, the period of active growth, is likewise important. Being a cool season grower, it gives green forage at a time when most of the summer growing native grasses and muhlys are still dormant and of low forage value.

Careful site selection, the use of proper equipment and good seed, planting at the most favorable time, and control of livestock have all contributed their part to the reseeding success thus far attained. Good ground and seedbed preparation is essential. The

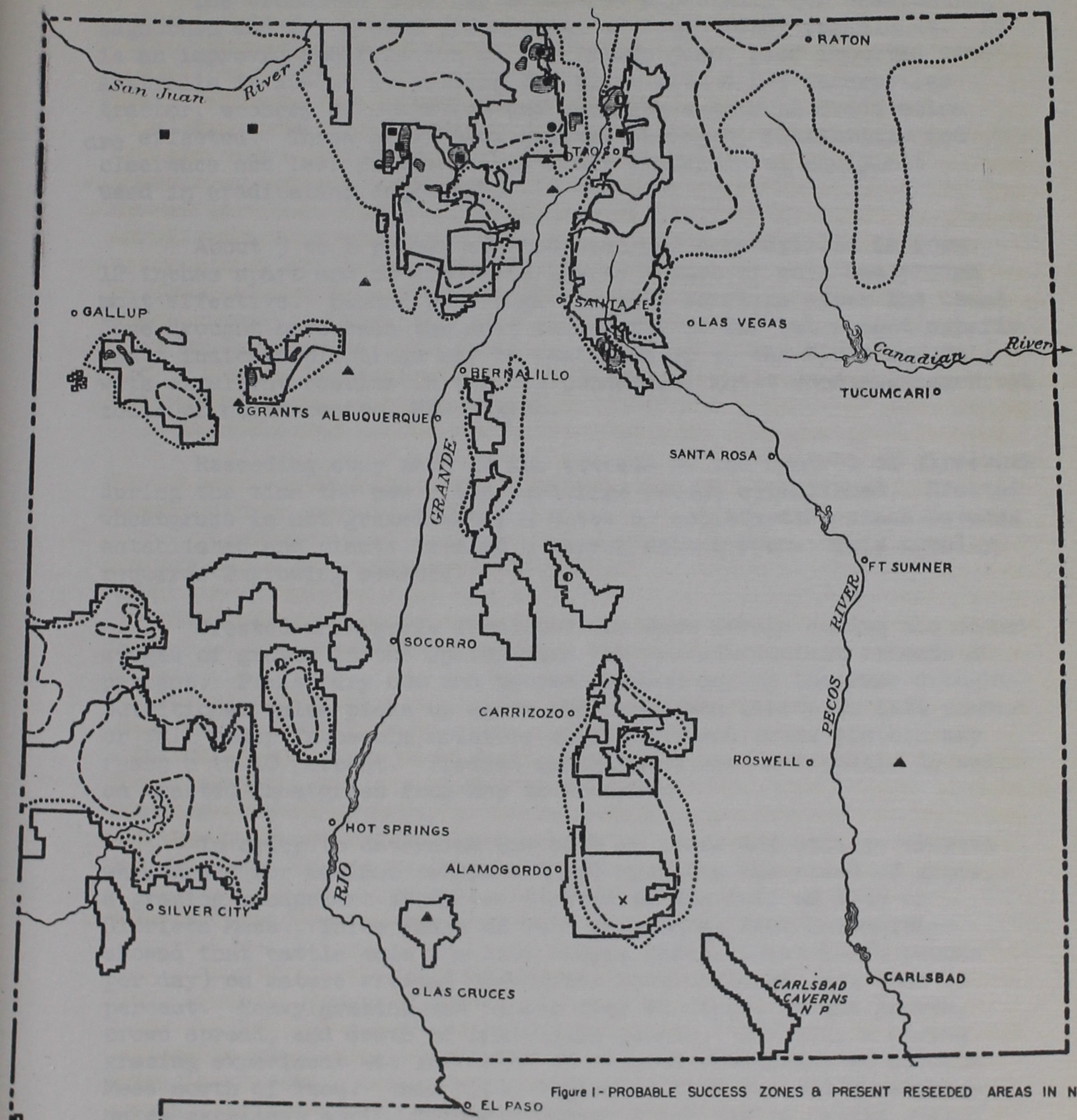

Figure 1 - PROBABLE SUCCESS ZONES & PRESENT RESEEDED AREAS IN NEW MEX

LEGEND

..... Lower Limit Of Crested Wheatgrass
---- Lower Limit Of Intermediate Wheatgrass
Sucessful Project Plantings (Over 1000 Acres)

EXPERIMENTAL PLOTS

●	PONDEROSA PINE	■	SAGE
⊖	TRANSITION PINE & WOODLAND	▲	SEMI-DESERT GRASS
◐	WOODLAND	×	MIXED CONIFER (OLD BURN

more complete the job of eliminating competing vegetation, the greater the number of grass seedlings that will become established and the better their growth. Of the many implements tested both experimentally and project-wide, the brushland plow has proven most satisfactory.

The brushland plow was developed especially for eradicating sagebrush and for ground preparation of rough rocky rangelands. It is an improved modification of the "stump jump" plow imported from Australia in 1947. By pulling two plows with a D-7 caterpillar tractor, economy of operation and complete sagebrush eradication are effected. These plows have greater strength, flexibility and clearance and less friction than other conventional equipment used in eradicating sagebrush.

About 5 to 6 pounds of good seed per acre drilled in rows 12 inches apart and covered with 1/4 to 1 inch of soil has proven most effective. Summer plantings starting sometime after the usual June drought have been the most successful so far but recent experiments indicate plantings may be continued up to the first snowfall with excellent results in the dry ponderosa, moist woodland-sagebrush zones of north-central New Mexico.

Reseeding owes much of its success to the control of livestock during the time the new grass seedlings become established. Crested wheatgrass is not grazed until a dense or satisfactory stand becomes established and plants develop a strong root system. This usually requires 2 growing seasons.

Crested wheatgrass furnishes the best forage during the early stages of growth in the spring when the protein content exceeds 20 percent. Plants dry out and become dormant during the June drought. Nutritional value picks up again when regrowth starts in late summer or fall under favorable moisture conditions and crude protein may reach 8 to 10 percent. Present indications are that cattle do well on crested wheatgrass from May to November.

In order to determine how best to graze and utilize crested wheatgrass for maximum return without damaging the stand of grass, a grazing management study was started in the fall of 1948 on Glorieta Mesa. Three years of fall grazing at four intensities showed that cattle made the best weight gains (about 1-3/4 pounds per day) on mature crested wheatgrass when utilized less than 55 percent. Heavy grazing use caused loss in vigor, height growth, crown spread, and death of individual plants. In 1952, a spring grazing experiment was initiated on crested wheatgrass at Cebolla Mesa north of Taos. This study indicates that crested wheatgrass makes excellent spring forage. Common grade native cattle grazed during the spring have made gains of from 2.6 pounds per day to over 4 pounds per day, the amount of gain varying with kind of cattle and grazing intensity. Cattle on crested wheatgrass usually have made 2.5 or more times the gain as similar cattle on native grama range grazed at the same season, and the wheatgrass has carried about ten times as many cattle.

Since present findings indicate crested wheatgrass should be utilized somewhat less than 55 percent to safeguard the stands, the

large project plantings have been grazed on this basis. Only the more recent plantings and those on which stock water was not available due to drought have not yet been grazed. Stocking capacity varies between 1.5 acres and 5 acres per animal-unit month depending on soil conditions and whether the stand is in the wet or dry zone. Under spring use, grazing is started when leaf growth reaches 4 or 5 inches and livestock are removed when about 50 percent of herbage has been consumed.

Intermediate wheatgrass

Although crested wheatgrass has proven far superior to other species in the 14-inch to 18-inch precipitation belt, intermediate wheatgrass, another cool-season grass, has been used with success in the more moist (above 18-inch) ponderosa pine zone. It is not as drought resistant as crested wheatgrass. Growth begins 2 to 3 weeks later in the spring than crested wheatgrass but regrowth begins sooner when rains start after the summer drought. When moisture is available, growth will continue through the fall until covered by snow. Because of this characteristic, intermediate wheatgrass can be used to assist in balancing seasonal forage supplies by extending the period of green forage on the range.

Intermediate wheatgrass is more palatable than crested wheatgrass to all classes of livestock and crude protein remains high in the spring and fall growth periods. Its habit of vegetative propagation by underground stems enables it to spread and form a sod. Intermediate wheatgrass will out-produce crested wheatgrass in the moist zone but suffers more readily during drought and under heavy grazing use. It should not be utilized too early in the spring and not as closely as crested wheatgrass.

Other species for the moist zone

Where annual precipitation exceeds 25 inches, smooth brome and orchardgrass were successful in limited trials. Recent examination of old experimental plots has indicated that native grasses have invaded these plots. Moreover, good success was obtained in seeding some native grasses such as Arizona and sheep fescue but these have not been used on large-scale plantings.

Dry Woodland-Sagebrush-Grassland Zone

Below 14 inches annual precipitation, success in reseeding trials has been quite limited. In the dry woodland type near Corona and in the San Augustine Plains, limited success was obtained with blue grama, alkali sacaton, and sand dropseed on an experimental basis. At Roswell, Caucasian bluestem and black grama showed promise but need further testing. Similar questionable and very limited success was obtained at other plots in the southern part of the State and no specific recommendations can be made relative to suitable grasses.

Chamiza (four-wing saltbush)

The shrub chamiza is the only species that has constantly given success in experimental plantings in the drier areas. Excellent results with chamiza have also been obtained in the intermediate 14- to 18-inch rainfall zone and this browse could well be used to a greater extent in mixed plantings with crested wheatgrass.

Chamiza is relished by sheep and cattle and is green and palatable yearlong. During the winter it is a valuable forage in northern New Mexico when other shrubs and grasses are covered with snow. Chamiza is very nutritious and its crude protein content ranges from 10 percent in late fall and winter to 22 percent during the growing season. Grazing experiments in Colorado indicated that cattle on summer shortgrass ranges made their greatest gains on pastures where chamiza was present. Cattle on blue grama-saltbush pastures gained about 10 percent more weight than on comparable upland blue grama ranges.

Chamiza is well adapted to many habitats in New Mexico, especially within the sagebrush-woodland zone, and is notable for its drought resistance. Apparently, there are no lower rainfall limits in New Mexico for it grows even in the more arid portions. However, plants do not grow vigorously above 7,200 feet. Chamiza will grow on shallow soils but best growth is on deep alluvial soils as it develops an extensive and deep root system. It tolerates a small amount of alkali and gypsum and free lime is needed for normal growth.

Success in planting chamiza depends on source of seed as well as amount, depth, and time of seeding. Chamiza seed collected near Taos has given good results throughout the State whereas seed from Corona and the Jornada gave good results only in southern New Mexico. Shallow, less than 1/2 inch, depth of seeding has produced the best results, with spring sowing the best followed by midsummer.

COST OF RANGE RESEEDING IN NORTHERN NEW MEXICO

H. B. Pingrey

Data collected on man and equipment time spent in land preparation and seeding of crested wheatgrass on northern New Mexico rangeland indicate that such reseeding will cost about $7.25 an acre.

These data are shown in detail in table 1 for a D-7 caterpillar tractor pulling two brushland plow units covering an 18- to 20-foot swath in land preparation. Seeding was accomplished by pulling two wheat drills behind a medium sized wheel tractor.

In a stony, rough to rolling topography, covered with a stand of sagebrush, land preparation accounts for 52 percent of the total per acre cost. Seeding represents about 31 percent, while risk of failure of securing a stand and non-use of capital expenditure in reseeding for a 2-year period amount to 14.5 percent. Interest and taxes on land, at an assumed value of $1.50 per acre, if such land were owned, account for less than 2 percent of the estimated per acre cost.

The Forest Service has found by experience that the brushland plow, designed and modified by them for use on rocky, rolling to steep lands, is the most effective means of eradication of sagebrush and other browse.

The physical inputs of man labor, and equipment for three types of equipment used in land preparation are shown in table 2.

Table 2.-- Inputs of man-labor, tractor hours, fuel and oil in land preparation for reseeding native range, forested areas of northern New Mexico, 1953

Equipment		Acres	Acres	Inputs			
				Per acre		Per tractor hour	
Tractor	Plow	Plowed	Per hour	Man hours	Equip. hours	Fuel gal.	Oil qts.
D-7	Brushland	6042	3.08	.57	.33	4.94	.91
D-7 & 8	Towner	1080	1.70	.90	.60	4.47	.21
D-4 & 6	Wheatland	1965	1.70	1.09	.62	2.08	.49

Examination of these cost data, table 1, shows that equipment cost appears large. For example, cost of a D-7 tractor and brushland plow in land preparation will approximate $6.58 per hour of tractor use or $2.66 per acre of land plowed. Since a tractor of this type will cost $14,500 or thereabouts, and each plow unit about $4,000, the total investment in equipment would be nearly $23,000. It is needless to state that the individual operator cannot afford to invest this much capital in such equipment for seedbed preparation and eradication of the sagebrush and other browse growing on the native ranges of northern New Mexico.

Table 1.-- Estimated cost per acre in reseeding native rangeland in northern New Mexico -- 1953

Item	Price per unit	Units per acre	Cost
A. Land preparation			
1. Labor	$ 2.00	.57 hrs.	$ 1.14
2. Equipment			
Tractor:			
Fuel	.17	1.63 gals.	.28
Oil	.12	.30 qts.	.04
Repair	2.25	.33 hr.	.74
Overhead 1/	1.90	.33	.63
Plow:			
Repair	.75	.66 hr.	.50
Overhead 1/	.71	.66 hr.	.47
			$ 3.80
B. Seeding			
Seed	$ .28	4.4 lbs.	$ 1.23
Labor	2.00	.33 hr.	.66
Tractor 2/	.92	.23 hr.	.21
Drill 3/	.44	.40 hr.	.18
			$ 2.28
C. Land			
Taxes	$ .0212	1.50 dollars	$ .03
Interest	.06	1.50 dollars	.09
			$ .12
D. Other			
Risk	5%	6.20 dollars	$ .31
Non-use of capital 4/	6%	6.20 dollars	.74
			$ 1.05
E. Total cost			$ 7.25

1/ Per hour cost: D-7 tractor: depreciation, $1.31, interest 59 ¢.
brushland plow: depreciation, .55, interest 16 ¢.

2/ Per hour cost: rubber tired tractor: gas, 1.87 gallons @ .17¢; oil .075 quarts @ 12¢; repairs, 30¢; depreciation, 20¢; interest, 16¢.

3/ Based on cost of $400 with no scrap value and a usable total life of 1,950 hours, repairs, 22¢; depreciation, 20½¢; interest 1½¢.

4/ Two-year period.

It would be more economical for the rancher of northern New Mexico who contemplates reseeding a small acreage of sagebrush land to custom hire the land plowed since custom rates usually amount to 10 to 15 dollars per tractor hour depending on size of tractor. This rate includes the machine operator.

The custom operator must charge a rate somewhat above the cost data shown in table 1 in order to cover an overhead charge for moving from site to site which may be a considerable item in a rough, mountainous terrain.

It is doubtful that the ranch operator can afford to invest 3,000 to 3,500 dollars in a wheel tractor and grain drills for reseeding. Such work can be usually custom hired at 2 to 2½ dollars an acre, not including seed.

Is Range Reseeding Economically Feasible

The answer to whether reseeding of low productive native rangeland is economically feasible can be approached from several viewpoints.

Experience and available data show that the yield of air-dry forage on the sagebrush native range of northern New Mexico is very low. On an enclosed experimental plot on Cebolla Mesa, north of Taos, New Mexico, forage yield was 60 pounds per acre. The plot has been protected from livestock grazing for nearly 15 years.

What is the cost of such forage per ton and per cow year of grazing to a ranch operator in terms of land interest and taxes? Assuming a 6 percent interest rate on a land value of $1.50 an acre, plus a 3 cent per acre tax, one arrives at a cost of 12 cents per acre. At 60 pounds of total forage yield, the cost is $4 per ton of total forage unharvested on the range. Since it requires a minimum of at least 4½ tons of forage per year to maintain a cow, the feed cost figures out to be $18 per cow for a year. If only 50 percent of the forage was utilized, the feed cost, represented as interest and taxes on land only, would be $36 per year per cow.

It becomes self-evident why ranch operators cannot afford to own such unproductive rangeland for livestock grazing. It is far more economical to pay a grazing fee of 26 to 30 cents per animal unit month and let "Uncle" own the land.

If any increase in forage production is to be had in the present generation from the deteriorated, pine-woodland, sagebrush spring-fall range of northern New Mexico, it would seem that it must come from artificially reseeding the better lying range sites.

What would be this forage cost per ton and per cow if reseeding cost $7.25 an acre? To answer this question it is necessary to ascertain (1) forage yield on reseeded sites and (2) longevity of the reseeded grass stand. Such data for New Mexico conditions is rather fragmentary at present. Therefore, I have had to make what I consider to be reasonable assumptions as regards yield and longevity of reseeded sites.

Yield data of crested wheatgrass over the past few years indicate a variation of 600 to 1,000 pounds per acre under reasonably favorable precipitation conditions. Let us assume 800 pounds of total forage per acre.

As regards longevity, there are a few private seeded sites of crested wheatgrass which were planted about 12 years ago. However, in Union County this species of grass, planted 8 to 10 years ago, has failed to withstand the recent 2- or 3-year drought in that area. There is some indication that improper management and too heavy grazing may have been a contributing cause, along with the drought.

However, let us assume a 20-year life for a stand of crested wheatgrass.

At a reseeding cost of $7.25 an acre and a 20-year period of longevity, the capitalized annual cost of reseeding would be 36 cents per acre. Add to this value land interest and taxes of 12 cents an acre and we get a total cost of 48 cents an acre. With a forage yield of 800 pounds, the cost of forage would be $1.20 per ton. Total cost of forage per cow year - 4½ tons per cow - would be $5.40. At 50 percent utilization of forage, the total cost would be $10.80 per cow per year. This compares with the forage cost of $36 previously mentioned for land interest and taxes, if the present low productive sagebrush land were privately owned and only 50 percent of forage utilized.

At a 10-year period of longevity of grass stand, the forage cost per cow per year would be about $21 based on a land ownership value of $1.50 an acre with interest at 6 percent and taxes of 3 cents an acre.

It would seem that the possible lower production cost of unharvested forage from reseeded sites of 16 to 25 dollars per cow year warrants an expenditure of $7.25 per acre cost in reseeding the better sagebrush range sites.

At the quoted yield of forage production for native and reseeded range, it requires 13.3 acres of the native range to produce the same amount of forage as can be obtained from 1 acre of reseeded rangeland.

Assuming ownership of land, what do these data indicate in terms of invested capital in land to provide forage for a cow for a year?

For native range, the land investment would amount to $454 per cow. 1/

For reseeded range, the land investment would be about $171 per cow. 2/

1/ 303 acres @ $1.50 per acre for native range.

2/ 22-3/4 acres @ $7.50 per acre represented by $1.50 for native range plus $6 capitalized value of cost of reseeding (36 cents yearly cost based on 20 years of longevity of stand @ 6 percent interest rate).

Thus the reseeded range represents a lower investment of $283 in land sufficient to produce an annual supply of forage for one cow.

The comparative analytical approach which I have presented is fundamentally one of relationship of land area--capital investment in land area (interest) and taxes, expressed as a cost--required to produce sufficient forage for 1 year to maintain a cow.

This comparison might well be expanded to include comparative cost of fence and water development so as to utilize the range forage; other costs of ranch operation; calf crop percentage; and animal gains on native versus reseeded sites. Sufficient data has not been assembled as yet to present such an analysis of the economic benefits.

In passing, I might mention that in 1954 the spring seasonal cow-calf daily gains per head were about three times larger for crested grass reseeded sites than for native range.

Reseeding in the Plains Area

Some 20,000 acres of "go-back" or abandoned soil eroded crop land in Union County has been reseeded to blue and sideoats gramas and sand lovegrass. Cost data estimates have been obtained from farmers - ranchers who have reseeded varying acreages during the last 2 years. these data have not been analyzed as yet.

In general, these cost data will show compared to reseeding costs in northern New Mexico:

1. A larger cost for seed planted because of amount used and price of seed for species planted.

2. A higher land cost because of reseeding land formerly used for crop production.

3. A higher charge for risk in obtaining a stand of grass by reason of drought.

4. A lower cost of man labor and equipment used in reseeding since the only operation is drilling seed on land having a weed or some other type of forage cover grown the prior season as protection against wind erosion.

In conclusion, I should add that this research study, "Costs of Range Reseeding and Evaluation of Economic Benefits," is undertaken as a joint project by the Agricultural Economics Department of the New Mexico Experiment Station in cooperation with the Rocky Mountain Forest and Range . Experiment Station, Fort Collins, Colorado, and the U. S. Forest Service, Region 3, Albuquerque, New Mexico. This study is conducted by the New Mexico Experiment Station as a part of a Western Regional R.M.A. W-16 Project entitled "Economics of Range Improvement."

EFFECT OF DEGREE OF UTILIZATION ON DROUGHT KILL IN BLACK GRAMA GRASS

J. J. Norris

Perhaps one of the most damaging effects of continued drought is a high degree of death loss among the perennial, forage-producing grasses. These death losses run to nearly 100 percent in some instances and mean that recovery to maximum forage production is extremely slow. The actual amount of death loss is, of course, influenced by a number of factors which are interrelated in varying degrees. Severity of the drought both in deviation from normal precipitation and in the period of years which it covers is most important. It is known that reduction in plant cover occurs during drought even though grazing is strictly controlled or even eliminated. Some studies have shown that ungrazed ranges dropped one or more condition classes (a result of depleted vegetative cover) during a drought period.

The impact of drought on forage grasses is influenced by other factors among which the degree of utilization or removal of forage through grazing is foremost. During drought periods grass plants are carrying on essential life processes under stress, and herbage removal by grazing adds to their difficulties. Numerous authorities have pointed out that heavy overgrazing reduces forage production and greatly impairs the ability of the range to recover in years of favorable precipitation. This delay in recovery is a result of thinning of the original stand through death of the plants weakened by grazing pressure.

This report does not bring out any new facts but simply adds to the existing knowledge. It is particularly appropriate at this time because the drought we are now in or which we might hopefully say is broken, is the most severe on record. The area we are on has suffered 7 years of below average precipitation during the growing season. In 1947 growing season rainfall fell to 83 percent of the 28-year average. Three of the years since 1947 are the lowest on record and were 28, 32, and 45 percent of average.

To measure effect of degree of utilization on death loss of black grama grass, pace transect samples were taken in areas of heavy use and areas of moderate or conservative use. These samples show the percentage of ground cover (all grass whether dead or alive) and the percentage of live grass plants. In addition, complete counts of live grass plants on 0.01-acre blocks were made. These data are presented in Table 1.

Table 1. Ground cover and percent of live grass plants under two degrees of grazing in three pastures.

Degree of use	Pasture 3		Pasture 15		Pasture 2	
	Heavy	Moderate	Heavy	Moderate	Heavy	Moderate
Transect density %	9.0	15.0	3.3	17.0	6.0	10.0
Live plants %	5.0	9.0	2.0	9.0	1.0	1.0
No. live plants on 0.01-acre blocks	238	333	66	551	7	15

In pasture 3 the transects showed density to be nearly twice as great on moderately used areas as on heavily used areas and also nearly twice as many live plants. This means that the soil surface is better protected against damaging spring winds and that recovery should be nearly twice as fast on the moderately used areas. The same picture is indicated when the number of plants on 0.01-acre blocks is considered. In pasture 15, the differences are more striking with density being nearly six times as great on moderately used areas as on heavily used areas. There were nearly five times as many live plants on the transects in the moderate use zones. Again the 0.01-acre blocks bear out the transect data. Differences were not so great in pasture 2 but still slightly in favor of moderate use. The indications are that the drought effects may have been stronger here and overshadowed the grazing influence.

Certain points might be made in brief summary. Drought results in death loss of forage grasses even without grazing. Under grazing use death loss is increased and the rate of increase is closely proportional to the increased degree of use. Recovery following this drought will be slow but can be expected to be nearly twice as fast on moderately grazed areas as on heavily used ones.

UTILIZATION FOR RANGE RECOVERY IN RELATION TO PLANT REPRODUCTION REQUIREMENTS

K. A. Valentine

We have been shown earlier today how rangeland of this type has undergone and recovered from past droughts, and in the preceding talk something of the severity of damage to the range caused by the current or recent drought. It is our purpose here to discuss briefly some of the basic considerations that should be made in grazing management to promote recovery of such range as this. What we will point out will apply most specifically to this type of range but will also apply in a general way to other grassland ranges.

Now, turning attention to the range here, you will easily observe that it has consisted of good productive grass with a high soil protection value. Further, this cover was composed mainly of black grama grass, with a low percentage of dropseeds, or sandgrasses as they are sometimes called, and threeawn grasses. Many of you are well acquainted with this range and remember what it is like when in good condition. Others of you may have to draw on your imagination, visualizing practically all the dead grass as alive and with black grama clearly dominating - comprising 85 percent or more of the cover. The better grassland areas which you have seen earlier in the day, also give you an idea of what good condition range is on this site, but even the best of these do not equal the forage yielding and soil protecting value characteristic of the good condition. Quite understandably, the goal of our management is the re-establishment of this condition here.

Now it may be asked, why do we set up this high degree of cover and the particular species, black grama, as the criteria by which we measure recovery. We do this simply because (1) no lower degree of cover will provide the protection needed to hold the soil in sufficiently stable condition to support good production and (2) no other species consistently, year in and year out, provides this required degree cover. Our dropseeds, without question good range plants with respect to palatability and nutritive value in their best season, fall short in year round and year after year forage value in comparison with black grama and are even more deficient in providing sustained protection of the soil against wind erosion. We have areas on the range here where dropseeds were the most conspicuous plants before the drought that now show very critical soil erosion, instead of the still relatively stable conditions you see here. The threeawns, though they too have their special value in late winter and spring, also are lacking in sustained soil protection capacity. There are no other plants that will grow on this kind of rangeland that can be considered at all. The situation is not simply one of wanting black grama because it is a choice species and not being content with the value afforded by the other species; these other species are just not quite good enough to do what is required here.

Now while it is true that black grama is so superior and alone is the key to complete recovery of this range, the dropseeds and threeawns are valuable grasses that do play a most important part in the

early and middle stages of the recovery process. In fact, the whole process may be briefly described as one in which the plants which are highly prolific and capable of migrating considerable distances quickly, first return and establish a cover, and this is followed by the gradual replacement of these first invaders by the more stable black grama. Many of the early invaders will be quite worthless from the forage standpoint, such as snakeweed and a number of annual plants, but they will help to provide the necessary soil protection. Others such as the dropseeds and threeawns and certain palatable annuals, afford both ground cover and forage.

The reasons for the difference in performance of the dropseeds and threeawns on the one hand and black grama on the other, lie in differences with respect to their life cycles and types of reproduction. The threeawns and dropseeds depend upon seed production and seedling establishment for their reproduction and the dropseeds are especially very strong in this respect. They produce seed in great quantities, and favorable years witness dropseed reproduction and establishment proceeding at a rapid rate. At the same time the length of life in the dropseeds is considerably less than in black grama and this in combination with their somewhat periodic reproduction, tends to cause fluctuations and the instability of stand mentioned above. The same applies, perhaps to a lesser degree, for the threeawns.

Reproduction in black grama, as you may know, is chiefly by vegetative means. Seed production is very poor and seedling establishment is quite a rare occurrence under our hot dry climatic conditions. The numerous flower stalks to be seen on the plants in a normal season are quite deceptive. By far the greater part of them fail to produce seed even in seasons quite favorable for vegetative growth. In lieu of reproduction by seedlings, black grama reproduces by runners which grow out from the parent plants and produce new ones at distances of from several inches to about a foot from the parent plants. The establishment of new plants requires 2 or 3 years. It is obvious that this foot-by-foot process of spreading requires much more time to cover an area than does reproduction by seed and this is indeed a great weakness in black grama when it comes to restoration of a depleted cover. Under normal or near normal climatic conditions the process is quite steady, however, and this in combination with the longer life of the grass clumps in black grama produces the relative stability in the restored cover mentioned earlier.

The foregoing points are necessary background material for the better understanding of the degree of grazing use that is necessary to bring about full recovery of this range. We do not need to be greatly concerned about use to permit reproduction of the dropseeds and threeawns and certainly not at all about use of the annuals and unpalatable plants, such as snakeweed. The annuals and unpalatable plants will take care of themselves quite effectively. In the dropseeds and threeawns, ordinary grazing use which permits most of the seed to mature will take care of reproduction requirements. It is quite important, however, to practice grazing that is light enough to leave sufficient stubble of perennials and dead annual plants for control of erosion.

With black grama, however, the situation is quite different. The runners, upon which reproduction is dependent, grow out well above the

surface of the ground and are easily accessible to the grazing animal. Further, if reproduction is to proceed at a maximum rate, just as many of these runners as possible must be preserved from grazing and trampling. The use that we normally think of as being correct for black grama, 40 to 50 percent, does appear to be about right when we have in mind the maintenance of good rangeland, since under good range conditions reproduction requirements are low. Under the conditions that prevail here, this same degree of use would be very excessive. In fact any use of black grama on very poor range is excessive considering the need for reproduction and improvement; every bit of the plant production should go toward restoration of vigor and reproduction.

Now for a season or so there will actually be very little forage produced on this range, owing to the extreme drought damage. But shortly, following the return of normal growing seasons, palatable annuals and the dropseed and threeawn grasses will appear in considerable abundance. This will pose a problem in management here that did not exist before the drought. Then we could stock this range yearlong or any time during the year with about equal results so far as the range was concerned. The range was considered to be especially suited to winter use because of the abundant presence of black grama which is palatable and nutritious in winter. But now we have a stand of plants that will afford some properly usable forage and mixed right in the same stand a very light scattering of highly palatable, highly valuable plants, the black grama, that should receive the lightest degree of use possible--none at all for a time if that is possible.

We believe that in order to obtain the greatest value possible from the pasture and at the same time foster recovery to the greatest extent possible, our management here should be use during summer and early fall when the dropseeds and summer annuals are palatable and will bear the greater part of the grazing load, and during late winter and spring when the winter weeds and threeawns will bear the greater part of the load. This would mean staying out of the pasture in late spring and early summer when owing to the normally dry conditions cattle, if present, would turn largely to black grama and from middle fall through winter when winter dormancy and death of other plants would again cause the cattle to shift to the black grama.

Another type of management that would be particularly fitting for this range is in line with the forage reserve plan discussed by Mr. Moore, with perhaps a bit of modification. This pasture could be placed in a reserve status and kept that way for a period of years, stocking it to use the accumulated reserve at intervals of 2 or 3 years in order to avoid losing too much value from the reserve. This should be especially conducive to a rapid increase in forage production from the dropseeds if some of our records here on the ranch can be considered indicative. Here on plots exhibiting very poor stand and vegetation yield of 3.35 pounds per acre we have seen an increase to a yield of 425 pounds per acre in a 7-year period of favorable rainfall. This yield, coming from the dropseeds, has not been maintained at this high level, however, owing to the fluctuating nature of the dropseeds pointed out and the recent dry years.

WEIGHTS, GAINS, AND GRADES IN THE SELECTION OF RANGE CATTLE

R. L. Blackwell

The relative importance of hereditary and non-hereditary factors in the differences observed among animals for traits of economic value has received considerable attention in beef cattle research. In general the heritable differences have been found to make up a sizable part of the total variation in traits such as gains, weight for age, and type scores. This means that selection for each will be effective.

An additional problem which needs much study is the nature of the relationships among the different traits which the breeder wishes to improve. One needs to know whether the apparent association among traits are due to common environmental causes or whether they are due to genetic factors. Frequently this question arises: If improvement in one trait is brought about by selection, what will be the effect on other traits which are also important? If traits are genetically independent, a genetic change in one will have no effect on the others. If, however, a real genetic correlation exists between two traits a change in one will result in a change in the other. A positive genetic relationship results in improvement in both traits if selection is practiced for only one. A negative relationship brings about a decrease in merit in one trait as improvement is made in the other trait.

Weaning and yearling weights and grades and yearling gains of the experimental range cattle were studied in an attempt to determine the genetic relationships that exist among them. The accompanying table shows the general results of these findings:

Table 1. Genetic relationships among traits

	Weaning weight	Weaning grade	Yearling weight	Yearling grade
Weaning grade	Negative			
Yearling weight	Positive	Negative		
Yearling grade	Negative	Positive	Negative	
Yearling gain	Positive	Negative	Positive	Negative

Although these relationships are not very precisely estimated, we can postulate what probably will happen to other traits when selection is for weaning weight or when it is based on grade alone. These approximations are set forth below:

Table 2

Basis of selection	Average superiority of both parents	Related trait in the offspring	Estimated change
Weaning weight	20 pounds	Weaning grade	Minus 0.2 units
Weaning weight	20 pounds	Yearling weight	Plus 6 pounds
Weaning weight	20 pounds	Yearling grade	Minus 0.2 units
Weaning weight	20 pounds	Yearling gain	Plus 10 pounds
Weaning grade	1 unit	Yearling weight	Minus 20 pounds
Weaning grade	1 unit	Yearling grade	Plus 0.4 units
Weaning grade	1 unit	Yearling gain	Minus 6 pounds

Notice that these results refer to expected merit in the offspring when both parents have been selected for only one weaning trait. This is not the same as predicting the expected merit of the parents with regard to these related traits at some future time.

When selection is practiced for any trait the breeder should be reasonably sure that such selection will result in improvement in that trait or in some important related trait. Otherwise there is no basis for giving attention to that trait in selection. Simultaneous selection for both weight and grade will result in some cancellation in the response of correlated traits. The emphasis to give to these traits in selection will depend in part on the economic value placed on each by the breeder.

THE EFFECT OF THE DEVELOPMENT OF HEIFERS ON THEIR PRODUCTION

J. H. Knox

Among the reasons for breeding heifers as 2-year-olds instead of yearlings are that less feeding is required to develop the heifers to breeding age and that they may use some of the poorer range. Under such a plan the better range is reserved for the cows with calves and the steers, thus increasing the weight and condition of the animals marketed. Such a plan has been followed on this experimental range with widely varying results as the feed supply has varied from abundant to the extreme shortage which has prevailed the past 2 years. Fall weights when the heifers are long yearling were used. This is usually the last marketing season and therefore the last good opportunity for culling before they are bred as 2-year-olds. Average weights by years ranged from 683 pounds to 588 pounds while the individual weights varied from over 800 to less than 500 pounds. Such wide variation gives a good chance to study the effect of development at 18 to 20 months of age on the number and weight of calves which the heifers later produce. The first 3 years' records were used as the ones most likely to be affected by the early development of the heifers.

Chart I shows the effect of the yearling heifer weights on the weight of the first two calves. The lack of difference between the two heaviest groups is probably due to the rather small number in the over 700 pound class and to the fact that these things seldom come out just as you expect anyway. This chart does not show much more than the fact that larger heifers raise larger calves on the average than smaller heifers. We would expect heifers averaging 725 pounds to raise calves weighing 30 pounds more than heifers weighing 575 pounds due to inheritancy. The decrease here is 29 pounds which leaves no difference due to management and feed conditions.

Chart II, which shows the number of calves raised, tells a different story. Here we find less than 1 percent difference in number of calves raised by the groups weighing over 600 pounds as yearling but over 12 percent difference between these heifers and the ones that weighed under 600 pounds. This indicates rather strongly that heifers weighing over 600 pounds as yearling have a good chance to make regular producing cows while those that weigh much less than 600 pounds as yearling are pretty likely to be irregular in production. This may be brought out more clearly by the statement that 70 percent of the heifers weighing over 600 pounds raised a calf to weaning age each of the first 3 years, while only 42 percent of the lighter heifers had a perfect record for this period. For each 100 heifers weighing over 600 pounds, 250 calves were weaned in the first 3 years while only 215 were produced by the heifers weighing under 600 pounds.

In making up the third chart we took a little license with the figures by combining the calf crop for 3 years with the average weights for 2 years; although a little irregular we do not believe it changes the picture. If this chart can be taken as reliable, and it is probably

fairly so, we would conclude that in order to obtain near maximum production range heifers should weigh about 650 pounds at 20 months of age, but 600 pounds could be accepted as a practical minimum standard. This does not mean that 600 pounds is a satisfactory average weight for yearling heifers in the fall. In that case nearly half of them will be below the minimum standard. Nor is it practical to set a standard so high that all of them will weigh over 600 pounds. There are always a few poor doers in any bunch which should be culled. A reasonable goal would appear to be an average weight of about 650 pounds for long yearling heifers, removing any heifer more than slightly below 600 pounds. In most cases this will be about 10 or 12 percent of the heifers which may be considered a normal culling for this stage.

CHARTS SHOWING THE EFFECT OF THE WEIGHT OF LONG YEARLING HEIFERS ON THEIR PRODUCTION

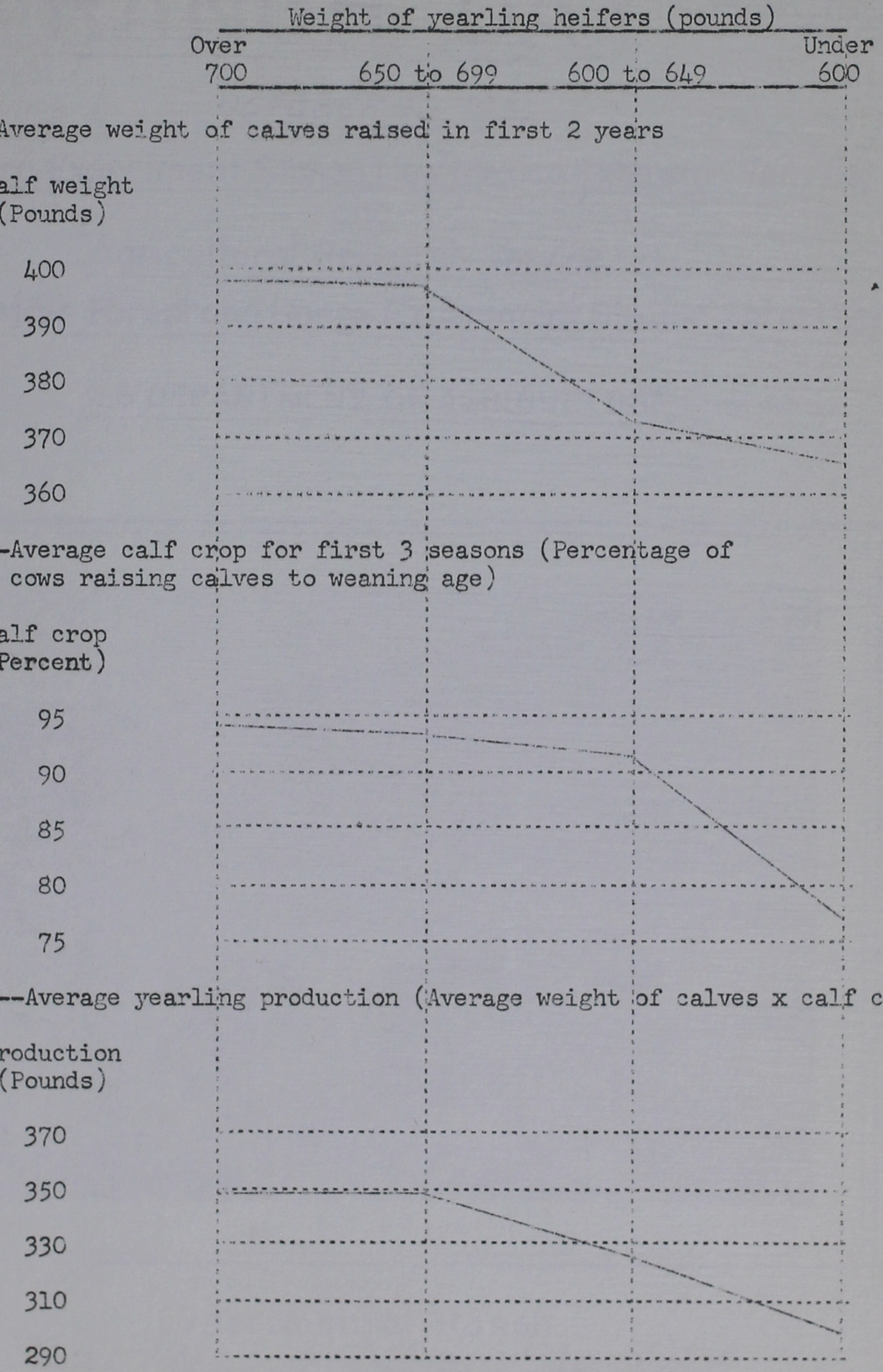

CHART I.--Average weight of calves raised in first 2 years

CHART II.--Average calf crop for first 3 seasons (Percentage of cows raising calves to weaning age)

CHART III.--Average yearling production (Average weight of calves x calf crop)